This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Colonial Museum and Geological Survey of New Zealand.

JAMES HECTOR, M.D., C.M.G., F.R.S.,
DIRECTOR.

REPORTS

OF

GEOLOGICAL EXPLORATIONS

DURING 1882,

WITH MAPS AND SECTIONS.

PUBLISHED BY COMMAND.

NEW ZEALAND:
BY AUTHORITY: GEORGE DIDSBURY, GOVERNMENT PRINTER, WELLINGTON.

1883.

120174

LIBRARY
STANFORD JUNIOR
UNIVERSITY

CONTENTS.

PROGRESS REPORT, BY DR. HECTOR.

	Page
Country examined—	
Auckland District	ix
Napier District	ix
Wellington District	ix
Nelson District	x
Westland District	x
Canterbury District	x
Otago District	x
Norsewood Lignite Deposit	x
Cape Colville Gold Field	x
Devonian Rocks	xi
Tufaceous Breccias	xii
Cabbage Bay Coal	xiii
General Deductions as to Reefs	xiii
Westland Gold Fields—	
Woodstock Gold Workings	xv
Ground-sluicing at Ross	xv
Ground-sluicing in Humphrey's Gully	xvi
Shag Valley, Otago—	
The Great Kakanui Fault	xvi
Malvern Hill Coal Mines, Canterbury	xvii
Collingwood Coastal Ranges	xvii
Formations present	xvii
Golden Ridge Gold Mine	xviii
Coal-bearing Strata	xviii
Motunau District—	
Moa Beds	xx
Saurian Beds	xx
Carrick Ranges—	
Antimony Mine	xx
Langdon's Mine, Greymouth—	
Auriferous Antimony	xxi
Terawhiti Gold Mines—	
Albion Claim	xxi
Reefton District—	
Antimony Lode	xxii
Granite Formation	xxiii
Devonian Formation	xxiii
Its Relation with the Baton River Series	xxv
Auriferous Series	xxvii
Coal Formation	xxviii
Miocene Formation	xxix

REPORTS.

	Page
The District around Norsewood, by S. H. Cox	1
Gold Fields of Cape Colville Peninsula, by S. H. Cox	4
Instructions by Dr. Hector	4
Narrative	5
Report	5
I. Geological Structure of the Country	5
Lower Carboniferous and Upper Devonian Rocks	5
Auriferous Rocks of Thames	8
Lower Miocene Beds	17
Rhyolitic Formation (Pliocene)	20
II. The Characters of the Reefs, with a Description of those Points which appear to have more or less regulated the Distribution of the Gold	21
Inclination or Underlie	22, 43
Moderate Hardness	22, 44
Dip	22, 44
Proper Bearing	22, 45
Thames District	23
Kuranui Mine	23
Moanataiari Mine	24
Golden Crown Mine	25
Cure Mine	26
Caledonian Mine	28
Waiotahi Mine	30
Queen of Beauty Mine	32
Alburnia Mine	32
Nolan's Candlelight Claim	35
Luck's All Claim	35
Karaka Creek	35
Owharoa District	35
Waitekauri District	36
Waihi District	37
Te Aroha District	37
New Find Claim	37
Diamond Gully Claim	38
Coquette, Eureka, and Victoria Claims	38
Young Colonial Claim	38
Queen of Beauty Claim	38
Golden Crown Claim	38
Arizona Claim	38
Waiomio District	39
Tapu District	40
Coromandel District	40
Tokatea Mine	40
Kapanga Mine	41
Blackmore's Claim	41
III. General Results	41
List of Specimens collected	46
On certain Alluvial Gold Workings in Westland, by S. H. Cox	51
Woodstock	51
Ross Gold-Mining Company	52

On certain Alluvial Gold Workings in Westland, by S. H. Cox—*continued.* Page
Humphrey's Gully Sluicing Claim 53
On Shag Valley, by S. H. Cox 55
Foliated Schists 55
Lower Carboniferous and Upper Devonian 55
Cretaceo-tertiary Series 56
Brockley Coal Mine and Surrounding District, by S. H. Cox 57
Anthracites 60
Altered Brown Coals in which the Percentage of Water is Not High 60, 61
Altered Brown Coals with High Percentage of Water .. 60, 61
Brown Coals 60
Comparative Statement of Brockley, Shag Point, and Westport Coals used on Locomotives 62
On the District between Collingwood and Big River, by S. H. Cox .. 62
Report 63
Granite 63
Metamorphic Rocks 64
Lower Silurian 66
Shaw and Wilkie's Claim 70
Lower Greensand 71
Cretaceo-tertiary Series 72
Pliocene (Blue Marls) 73
Pliocene (Old River-gravels) 73
Recent and Pleistocene 73
On a Deposit of Moa Bones near Motunau, North Canterbury, by A. McKay 74
On the Antimony Lodes of Carrick Ranges, Vincent County, Otago, by A. McKay 80
Lode No. 1 81
Lode No. 2 81
Lode No. 3 82
Lode No. 4 82
Pryde's Creek Lode 82
On Antimony Lode and Quartz Reefs at Langdon's Hill, Grey County, by A. McKay 83
Langdon's Extended Antimony Lode 84
Langdon's Reef.. 84
Albion (Boase's) Mine 84
Working Miners' 85
Wilson's Lease 85
On the Albion Gold-Mining Company, Hutt County, by A. McKay .. 85
Letter from Dr. Hector to Secretary of Albion Company 85
Report 86
On an Antimony Lode at Reefton, Inangahua County, by A. McKay .. 88
On the Geology of the Reefton District, Inangahua County, by A. McKay 91
Report 92
Description of District 93
Previous Observers and their Work 96
General Geological Structure 97
Granite and Metamorphic Rocks 99
List of Rocks collected 103
Devonian Formation 104
List of Specimens collected 116

On the Geology of the Reefton District, Inangahua County, by A. McKay —*continued.* Page

Carboniferous 118
Reefton Auriferous Series 118
List of Specimens collected 134
Rocks of an Intrusive Character 137
Quartz and Gold-bearing Specimens 138
Antimony Ore 139
Lead 139
Iron 139
Carbon Compounds 139
Lower Cretaceous and Cretaceo-tertiary Series 140
Great Angular Breccias 142
Quartz Grits and Auriferous Cements 144
Grits, Sandstones, and Shales with Coal 146
Brown Fossiliferous Sandstone 149
Impure Fossiliferous Limestone 150
Dark Marly Beds, with Concretions 150
Gritty Foraminiferous Coral-rag 150
Cobden Limestone 150
List of Mineral Specimens collected 151
Fossils 152
Upper Miocene Gravels 152
Pliocene Gravels and Drift 153
Recent 153

ILLUSTRATIONS.

		Page
Section of Lignite-Beds at Mangatewainui Stream		2
Section in Cutting near Ormondville		3
Sketch showing Position of Outcrops up Waiohanga Creek		7
Section from Beeson's Island to Kennedy's Bay		8
Map of Cape Colville Peninsula	To face	6
Section to illustrate Relation of Reefs to Bedding	To face	10
Section, Waiohanga Creek to New Devon Trig. Station		12
Section up Tapu Creek		14
Section, Waitekauri to Owharoa		15
Section through Te Aroha		16
Section through Miocene Beds, Cabbage Bay		19
Sections of Leader in Moanataiari Mine		25
Cut illustrating Turn in No. 9 Branch Leader		26
Plan and Sections of Junction of Hanging-wall Leader with No. 1 Reef, Golden Crown Mine		26
Cuts illustrating Distribution of Gold		27
Section through Reefs and Strata in Cure Mine		28
Sections showing Behaviour of Reefs		29
Plan showing Gold Mines		30
Section through Alburnia Mine		33
Sketch-Plan of Reefs in Alburnia Mine		34
Cuts showing Occurrence of Gold		36
Section showing Relations of Reef to Bedding	To face	38
Cut showing Pinching of Reef		39
Map and Sections of Ross Flat	To face	52
Map of Shag Valley	To face	55
Section, Waihemo Grange to Blue Mountains		56
Section through Brockley and Ayers's Mines		58
Map of Collingwood District	To face	62
Section on Line A–A of Map of Collingwood		65
Section on Line B–B of Map of Collingwood		66
Section on Line C–C of Map of Collingwood		68
Section showing Position of Auriferous Quartz		69
Section showing Occurrence of Leaders		70
Section on Line D–D of Map of Collingwood		71
Section on Line E–E of Map of Collingwood		73
Section on Line F–F of Map of Collingwood		73
Section showing Raised Beaches		74
Plan of Antimony Lodes of Carrick Ranges	To face	80
Plan of Leases on Langdon's Hill	To face	84
Plan of Albion Company's Mine	To face	86

	Page
Plan and Section showing proposed Tunnel of Albion Company's Mine to face	86
Plan of Bayfeild's Antimony Lease, Reefton .. .. .. To face	88
Plan of Inangahua Valley .. .. To face	96
Section across Inangahua Valley	98
Section of Devonian Strata, Inangahua Valley..	109
Section of Devonian Rocks at Rainy Creek	110
Section of Devonian Rocks at Lankey's Gully	111
Section on Inangahua River	113
Plan of Gold-mining Leases, Reefton and Waitahu Survey Districts, to face	118
Section showing Contorted Structure of Green Slates of the Auriferous Series	122
Section on Inangahua River, near Reefton	123
Section from Reefton to Bridge over Inangahua River	126
Section from Black's Point to Cement Town	127
Section through the Gorge of Boatman's Creek	128
Section, Little Boatman's Coal Mine to Specimen Hill	129
Section showing Junction of Auriferous Rocks at Larry's with underlying Granites	130
Section across Cement Company's Lease, Lankey's Gully	146
Section of Coal Strata at South Side of Boatman's Creek, at Capleston ..	147
Section from Devonian Belt across Garvie's Creek to the Granite ..	149

ERRATUM.

Page 99, line 20 from bottom, *after* "there being" *read* "no."

REPORTS OF THE GEOLOGICAL SURVEY.

PROGRESS REPORT, 1882.

THE appended reports by the officers of the department give, in a detailed form, the results of the survey work during the year, in the course of which several important additions have been made to our knowledge of the geological structure of the country. These do not, however, involve any marked alterations in the system of classification, but rather tend to confirm the accuracy and applicability to all parts of the country of the general scheme which has now been arrived at.

The following districts have been surveyed during the period to which these reports refer:—

AUCKLAND DISTRICT.

1. The interior district, including Rotorua and the Waikato Valley to Taupo Lake, was visited on several occasions, attention being chiefly directed to the distribution and mode of occurrence of the various mineral and thermal springs, the study of the soils, and of the adaptability of the country for settlement.

2. The survey of the Cape Colville Gold Field has been continued, and the new district of Te Aroha has been mapped and reported on.

NAPIER DISTRICT.

1. The Forty-Mile Bush, in the vicinity of Norsewood, has been further examined.

WELLINGTON DISTRICT.

1. The upper and eastern part of the Wairarapa Valley has been surveyed, and the true position of the igneous rocks that occur there has been determined.

2. The reported discovery of auriferous reefs at Terawhiti and other places in the vicinity of Wellington has led to several special surveys being made.

NELSON DISTRICT.

1. The survey of the very interesting mineral country in the vicinity of Collingwood has been extended so as to include the upper part of the Aorere Valley and the coast ranges.

WESTLAND DISTRICT.

1. Special examination has been made of the mining claims at Humphrey's Gully, Ross, and Langdon's; and the survey of the Reefton District has been extended so as to cover the localities where tin ores are reported to have been found.

CANTERBURY DISTRICT.

1. The coal fields at the Malvern Hills and at Motunau have been again examined and reported on.

OTAGO DISTRICT.

1. The Jurassic strata at Catlin's River have been again examined in order to test the practical value of various thin coal-seams that have been discovered.

2. The relative age of the great fault that affects the strata of the Kakanui Range has been again studied.

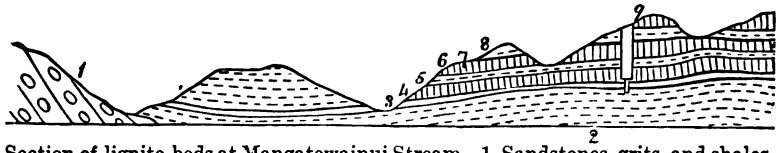
In addition to his field-work Mr. Cox has rendered an important service to geological science in the colony, that will be particularly useful to teachers and students in the various colleges, by making a thorough revision of all the mineral species which have been recorded as occurring in New Zealand.* Mr. McKay has in a similar manner employed himself in the rearrangement, mounting, and preliminary classification of the very large stock of fossils which have now been accumulated. The examination of these revised collections has been so far advanced as to indicate that the proportional number of extinct species in the Tertiary strata will be greatly increased, and that the Awamoa (or Pareora) formation, which closes the marine series in the South Island and marks the last great period of emergence of the land, has been properly placed in the Lower Miocene period.

NORSEWOOD LIGNITE.

In January Mr. Cox, the Assistant Geologist, was directed to visit the Norsewood District, and to report on discoveries which had led the prospectors to believe a deposit of coal existed in the district.

* Trans. N.Z. Inst., Vol. XIV., p. 418; Vol. XV., p. 361.

The result of his examination of the district confirms the previous surveys,* and shows that coal-measures do not occur there on the surface, and there is no reason to suppose they will be found in depth. The only carbonaceous deposits which have been found are some thin seams of very inferior lignite, in which the percentage of water was as high as 33, and of ash 44 per cent. The works which have been carried on to prospect these beds are injudicious, a shaft having been sunk on a spur for a depth of 75 feet, and a bore-hole put down at the bottom for another 25 feet, without gaining more information than could have been acquired from a careful examination of the surface, as may be gathered from the following section :—



Section of lignite-beds at Mangatewainui Stream. 1. Sandstones, grits, and shales, with broken plants (Triassic?). Lignite series, including—2. Blue sandy clays; 3. Lignite 3 feet, fireclay 3 feet, lignite 3 feet; 4. Sandy clay, with broken plants; 5. Fine quartz sand; 6. Sandy clay, with broken plants; 7. Lignite, 3 feet; 8. Sands and clays. 9. High-level subangular gravels.

CAPE COLVILLE GOLD FIELD.

His attention was next directed to the Cape Colville Peninsula, in order to make a further study of the geology of this most difficult district, and to endeavour to obtain further data which would be of use to the gold-miners in the prosecution of their work.

He has divided his report under two heads: I. The geological structure of the country. II. The character of the reefs, with a description of those points which appear to have more or less regulated the distribution of the gold.

As regards the geological conformation of the district he concurs in the opinion that the basement rock of the district is composed of compact slates and sandstones, probably of Lower Carboniferous or Upper Devonian age, which appear at the surface from Tapu Creek to Matawai at Coromandel, and are again seen as a small patch near Tararu Point; and he points out that they again crop out on the shores of the Bay of Plenty, near Waihi.

The slates, which never are intersected by cleavage-planes, are of a green, blue, or brown colour and fine grain, and are in

* Geological Report, 1876–77, p. 80.

many cases very hard; their strike is from W. to N.W., and their dip varies from E. to W. at different localities. The only intrusive or highly altered rock mentioned is the felsite, which occurs associated with the slates at one or two points—viz., Tararu Point; Gentle Annie Creek, Tapu; and Tokatea Mine, Coromandel.

The next formation in ascending order is the auriferous series of the Thames, which rests with distinct unconformity upon the upturned edges of the slates. This series consists of alternations from a coarse tufaceous breccia to a fine-grained tufaceous sandstone, interstratified with which are belts of hard green tufas and a fine-grained indurated mudstone, which, being traversed by joints, is termed by miners "shingly ground."

In the Shortland District these beds strike N.N.E., and dip to the W.N.W. at 10° to 30°, and are traversed by faults or slides and dry watercourses. Two of the main faults are very conspicuous. The first of these strikes N.E. up Tararu Creek, bringing to the surface, on its north-west side, the breccias which form the base of the auriferous formation; the second, known as the great slide, has an east-and-west course, and divides the deep workings of the Thames from those which are situated on the higher ranges up the Moanataiari and Waiotahi Creeks. A similar succession of beds may be studied at Tapu Creek, where they are also found to be resting unconformably on the slates; and a similar section may be seen at Coromandel, where the lower levels of the Tokatea Mine are situated in the slates, the auriferous formation resting on them and dipping away towards the Union Beach Mine; while another outlier occurs at the Tiki. To the south of the Thames, according to Mr. Cox, these rocks occupy a somewhat greater surface-area, stretching back at Tairua to form the main range, gold-workings having been opened in them at Waitekauri, Owharoa, Karangahake, and Te Aroha, at which latter place a most instructive section is reported, all the rocks characteristic of the Thames Gold Fields being represented, and cropping out on the surface. Overlying these beds, and with an unconformity which can be clearly made out at some places, but is more obscure at others, comes a series of volcanic rocks of Miocene age, consisting of coarse trachydolerite breccias, tufaceous sandstones, and clays, with which are associated small nests and patches of coal. These are identical in character with beds which occur at Manukau north head, and again at Mahurangi, where explorations for coal have been

unsuccessfully attempted. On the Cape Colville Peninsula coal has been found associated with this formation at Cabbage Bay near Coromandel, at Mata Creek near Tapu, and at Ohinemuri near Paeroa; but, except in Cabbage Bay, no seams have been reported which are of sufficient thickness or purity to be of any commercial value. This formation is traversed by dykes of dolerite, and it rests indiscriminately upon the auriferous series and the slates. It is referred to the Lower Miocene period, because to that formation the beds on the mainland belong which most closely resemble them, and because it is overlaid by a yet younger formation in the Ohinemuri Valley. This is also of volcanic origin, but composed of pumiceous clays and beds of rhyolite porphyry, as exhibited at Waterfall Creek and at Waihi. These latter strata occur filling depressions in the auriferous rocks, and have been met with in the workings of the Radical Mine at Owharoa, where they were mistaken for a slide when first cut. Mr. Cox considers this formation as of Pliocene age, and that they are the youngest beds met with in the district, excepting the river deposits of the Thames and tributary rivers, which contain rolled boulders of dolerite, trachyte-quartz, rhyolite, and obsidian.

Regarding the characters of the reefs, Mr. Cox has devoted much attention to this branch of his subject, and has carefully collected all the available information from the managers of the various mines. As might be expected, this information is by no means complete, since the working-plans of the mines were not intended to depict all the accompanying characteristics of the reefs where they were rich, or the changes which took place when they became poor; and, moreover, it is but seldom that the same manager has controlled a mine from its commencement. Mr. Cox has nevertheless been able to collect valuable information concerning the peculiarities of the reefs, and particularly on those points which appear to have regulated the occurrence of gold in payable quantity. It is to be hoped that his report will incite the mining managers to careful observation, as they have ever-recurring opportunities of noting the changes in character of the reefs, the circumstances under which they improve, and the lie of the various belts of rock through which the reefs pass.

General Deductions.

The results which Mr. Cox obtained from this branch of his work may be summarized as follow: The average angle of dip

of the reefs does not in any way affect the distribution of gold, for rich reefs have been worked which varied from vertical on the one hand to quite flat-lying reefs on the other; but irregularity in the inclination of the reefs has been a most important factor in determining the position of the rich patches, the steeper portions having, with but few exceptions, proved the richest.

It is also of great importance that the reefs should be traversing a kind of rock which is favourable for the production of gold, and it has been found that in a moderately hard tufaceous sandstone the reefs are most productive, and that where this class of rock is pyritous, or carries small black veins which run into the reefs, rich deposits generally occur.

In one respect Mr. Cox appears to arrive at different conclusions from some previous observers, as he considers that, although the presence of pyrites in the enclosing rock is a favourable indication, yet it is not from the decomposition of the pyrites that the gold has been derived, but rather that this mineral has been deposited contemporaneously with and by the same means as the reefs and gold themselves, viz., mineral waters which, percolating through numerous small joints and fissures in the rocks, decomposed its felspathic constituents, and deposited crystals and crystalline grains of pyrites. At the same time it is necessary to point out that there are many important exceptions to this statement, as instances have been observed, especially at Coromandel, of rich deposits of gold formed by secondary decomposition of the auriferous pyrites contained in the bed-rock. The dip of the shoots of ore, in his opinion, appears to be controlled by the lines of intersection of hanging-wall leaders with the main reef; but the evidence on this point is still very imperfect. The bearing of the reefs also appears to have had considerable influence in determining the position of the rich patches of gold at the Thames, it being generally admitted that any change in the bearing of the lodes is attended by a corresponding change in their auriferous character. He points out that the initial fracture of the lodes of the district is on a north-east line, but that the bearings of the auriferous reefs vary from N. 10° E. to N. 80° E., and that these vary in themselves along their course. Where observations have been made it has been found that where the course of the reefs has changed either from a more northerly or easterly course toward a north-east direction their auriferous character

has generally improved. It will thus be seen that the auriferous characters of the reefs depend—

1. Upon their underlie at any one point of the reef, the steeper parts being generally the richest;

2. Upon the course of the reef at any one point, those parts which most closely assimilate to a N.E. course being generally the richest.

3. It is imperative that the reefs be passing through a class of country which is favourable for the occurrence of gold, and it thus becomes a most important point at the Thames to know accurately how these different belts of country run. Mr. Cox has shown that, whereas the reefs approximate more or less to a N.E. course with a N.W. underlie, the strike of the strata is about N.N.E., with a dip to the W.N.W. at an angle of 1 in 2, so that they dip at a flatter angle than the reefs which also cross them diagonally along their strike.

The general result of his work has confirmed my opinion that there is no reason to apprehend any falling-off in the productiveness of the reefs in the deep levels, but that, subject to the foregoing conditions, in all probability they will continue to prove auriferous to as great depths as it will be practicable to work them.

WESTLAND GOLD FIELDS.

Woodstock Gold Field.

During the month of May Mr. Cox visited some of the alluvial gold-workings of Westland, and reported on Woodstock, Humphrey's Gully, and Ross Flat. He states that at Woodstock about three hundred claims had been marked out at the date of his visit; that the average depth of the wash was from 50 feet to 70 feet, the thickness of the wash from 2 feet to 10 feet, and the yield from 4 dwt. to 1 oz. to the load. The bottom on which the wash rests is the marine Miocene strata of the Kanieri series, known locally as the "Brighton bottom." The miners appeared satisfied with the prospects of the field.

Ground-sluicing at Ross.

He reports that the Ross Gold-Mining Company has a lease of ground comprising most of the leases originally held on the Ross Flat, including the Prince of Wales, Scandinavian, Morning Star, Cassius, and Kohinoor leases, besides a considerable area of as yet unproved ground. During a period of thirty-two and a half weeks these claims obtained 11,543 oz. 9 dwt. 21 gr. of

gold, after which the water became too heavy for the drainage machinery which had been erected. The present company has now erected a double set of pumping machinery, worked by powerful water-engines set over a shaft 269 feet deep, by which the water is lifted to the level of the main tunnel, which is 90 feet below the surface and has a length of 98 chains. This tunnel has lately been connected with the abandoned claims under the township, and some very rich ground has been found, the wash having a width of 100 feet and a depth of 7 feet, and yielding about 7 dwt. of gold to the load.

Ground-sluicing in Humphrey's Gully.

The Humphrey's Gully Sluicing Claim, he reports, is another extended alluvial claim, owning 98 acres of land leased from the Hokitika Harbour Board. They have from 100 feet to 300 feet of wash distributed over most of their property, and are bringing in water in sufficient quantities to supply 50 Government heads per day of eight hours. Wherever the wash is tested gold can be obtained, and it does not appear to lie on any bottom, but to be distributed throughout the wash, so that he thinks that there is a fair prospect of this claim proving remunerative to the shareholders.

SHAG VALLEY, OTAGO.

Mr. Cox was next directed to investigate the relative position of the crystalline limestones which occupy the northern side of the Shag Valley, in Otago, about the age of which there is some uncertainty. His opinion is that they occur interstratified with slates and sandstones, which strike N.N.E. and dip E.S.E., and belong to the Lower Carboniferous rocks or Maitai series. These beds are cut off from the Upper Devonian or Te Anau rocks, which form the main range, by a fault which traverses the country in a N. 65° W. direction, and has its downthrow to the south-west. As this supposed fault would be a continuation of that which affects the coal-bearing strata from Puke Tiwhatai (Puke Ivitai) to Shag Point, it must have resulted from movements during the Tertiary period, and the downthrow may have led to the preservation of a valuable area of deep coal in the lower part of Shag Valley.

MALVERN HILLS COAL.

In August he visited the Brockley Coal Mine at South Malvern, to report on the extent of altered coal existing in the

district which could be profitably worked. He reports that the Brockley coal-seam is standing vertical, having been tilted to that position by a dyke of dolerite which encloses the seam between it and the quartz porphyries that form Pullwool Peak. The altered coal has been traced for about half a mile along its strike, and, allowing that it may be worked to a depth of 1,000 feet, he calculates that 300,000 tons of coal would be available. He reports that to the southward of the dyke two other seams of altered coal, 4 feet and 2 feet thick respectively, are cropping out, and dipping to the southward at an angle of 30°. They are overlaid by a dolerite floe, but, no work having been expended on these seams, it is impossible to say what extent of them exists.

COLLINGWOOD COASTAL RANGES.

During October, November, and part of December Mr. Cox was engaged on the survey of that part of the Collingwood District which is bounded by the Aorere River on the south-east and by the coast-line between Collingwood and Big River on the north-east and north-west, the south-west boundary being represented by a line drawn from the mouth of Big River to the Gouland Downs.

The formations met with he has classified as follow:—

I. Recent and Pleistocene.
II. Pliocene.
V., VI. Cretaceo-Tertiary.
VII. Lower Greensand.
XIII. Lower Silurian.
Metamorphic Rocks.
Granite.

He describes the two belts of granite in the district, one of which is a true granite-porphyry, the other a syenitic gneiss-granite. The first of these forms Rocks Point and the coast-line as far as Karanga Point, where it recedes inland, and is not seen on the surface beyond the Turimawiwi. It is again exposed at House-roof Hill, near West Wanganui, and again near the mouth of the Kaituna, and at Pakawau. The second belt is seen on the Gouland Downs, where it forms a hill at the head of the left-hand branch of Big River, and crops out again in Lead Hill, Mount Olympus, and forms the mass of Separation Point, from Tata Island to Astrolabe Harbour. It has hornblende throughout its mass, and carries schorl as an acces-

sory mineral at Tata Island. The metamorphic rocks consist of greenish-coloured fine-grained mica-schists, interstratified with bands of a more gneissose character, and belts of crystalline limestone or marble. They are met with on the western side of the Aorere River, extending along the flanks of the range from Kaituna River to Pakawau, and are not seen in any other part of the district. The Lower Silurian rocks consist of sandstones and slates, which form the main mass of the Wakamarama Mountains, from the Kaituna River to the Gouland Downs. They have generally a N.–S. strike, and a westerly dip at angles varying from 30° to 45°, but on the eastern side the dip is much steeper. Some belts of black slate, interstratified with these rocks, contain graptolites, and they are traversed by reefs which, in the vicinity of the Golden Ridge, have been proved to be auriferous, and one mine has been at work in them for some time. Gold-bearing quartz has been found at other localities, as at Friday Creek, but hitherto the reefs have not proved sufficiently rich to pay, with the exception of that worked at the Golden Ridge Mine. The strike of the auriferous belt would carry it through to the western side of the Gouland Downs, and rocks of a similar character occur in this locality, although no reefs have as yet been found there.

The strata which Mr. Cox includes as Lower Greensand beds are those which comprise the bituminous coals of the Wallsend Mine, consisting of conglomerates, breccias, and hard indurated sandstone, having between the conglomerate and sandstone interstratified beds of shale and several thin seams of good bituminous coal and fireclay. This formation, which has been described at length in previous reports,* rests, at an altitude of 800 feet, upon the upturned edges of the metamorphic rocks, and is continuous from the Ramparts to Pakawau, at which latter place the coal-seams are at and below the sea-level. Its members dip in a north-west direction, and are overlaid by the upper coal-measures of the Cretaceo-tertiary series. In Plumbago Creek, and again at Pakawau, Mr. Cox holds that it is the coal having been altered by local conditions which gives rise to the veins and irregular deposits of graphite. This mineral occurs as boulders in a drift, and also in a seam which is standing nearly vertical. Unfortunately it has so far proved to have very little commercial value, as, although much of the

* Hector: Geological Reports, 1867, p. 19, and 1871, p. 158.

stone looks very well on the surface, when broken it proves to be nothing but scale, very little plumbago being found through the seam.

In the Cretaceo-tertiary series that overlie these lower coal-measures the lowest beds seen are sandstones, shales, and grits, with beds of brown coal, it being in these that the West Wanganui Coal-mine is worked. In the West Wanganui District they cover an area about five miles in width, which may be traced from the north-east end of the West Wanganui Harbour to the Paturau River, south of which the exposure is narrower, but the beds are seen as far south as Big River. They dip coastwards, and are overlaid by a belt of grey calcareous sandstone, which forms the second ridge inland from West Wanganui to Punipawa, after which they occupy the seaboard to Big River, the remarkable Kaipuke cliffs being composed of them; and, above these, limestones occur along the coast-line from just north of Punipawa to the West Wanganui Heads.

Above these beds there is a considerable break in the sequence, the next seen being the Pliocene blue marls, which occupy an area of some extent in the valley of the Aorere River, and along the coast-line towards Pakawau, and also in the direction of Takaka. They are characterized by the occurrence of marine organisms, and have undergone very little movement since their deposition: at the same time they are contemporaneous with certain old river-gravels which mark a former course of the Aorere River, and lie at a much higher level than the present bed of the river. Since the elevation of the land the Aorere has cut through and removed a large area of these marls near the Port of Collingwood, and has deposited recent river-gravels as low-level terraces.

MOTUNAU DISTRICT.

The first work of the season by Field Assistant Mr. A. McKay was an examination of a deposit of moa bones near Motunau, North Canterbury, lying partly on the property of Mr. Arkle and partly on land belonging to the Hon. W. Robinson. He states that the bones occur in a bed varying from a few inches to 18 or 20 inches thick, and they are found in gravel, sandy clay, plastic clay, and peaty lignite, and are overlaid by a thickness of 10 or 12 feet of gravel, sand, clay, and loam. From a paddock of 30 square feet area, which was opened, portions of the skeletons of at least thirty birds were extracted, and

the deposit appears to be very extensive; but no complete skeleton of an individual moa could be obtained. The moa bones collected belong to only two species, and those of *Dinornis elephantopus* constitute fully nine-tenths of the whole. Remains of other birds are rare, with the exception of a few fragments of the great extinct vulture, *Harpagornis moorei*. He also made collections from the Tertiary and Cretaceo-tertiary rocks of the district, obtaining at Motunau several new corals from the marls above the Amuri limestone, and a single vertebra of *Mauisaurus haasti* from the beds immediately below the Amuri limestone; and the coal-beds in Happy Valley were traced south, and identified as belonging to the same horizon as the coal-seam in the upper part of Motunau Creek. On the western slope of the coast range, between Gore Bay and the mouth of the Waiau-ua, a few fragments of *Leiodon* and *Mauisaurus* were obtained from the saurian beds. The ranges between Omihi and Greta Valley, and on the western part of the Cheviot, he classes as Triassic from the resemblance of the rocks to those of the Okuku Range, in which *Monotis salinaria* was found; but states that at Cheviot rocks of Liassic or Oolitic age are largely developed. The Triassic rocks west of Motunau contain lodes of hæmatite, one on the Happy Valley Run being 6 feet in thickness.

CARRICK RANGES, OTAGO.

His next report relates to the antimony lodes of the Carrick Ranges, in Vincent County, Otago, which are situated about four miles west of Bannockburn, and 3,000 feet above sea-level. Outcrops of stibnite have been found along a N.–S. line for a distance of a mile or more, but 3 to 4 chains is the extreme length to which any individual outcrop has been proved. The thickness of the antimony-bearing portion of the lodes varies from 6 inches to 20 inches, and, as far as yet shown, the bunches of ore are thickest in the lower levels. The lodes are traversing grey, foliated, and highly-contorted mica-schists, dipping S.W. and S.; but in the neighbourhood the same rocks have a W., E., and N.E. dip, showing that the lodes are in a very much disturbed belt of country. To the north-east the lower contorted foliated schist is found; while more to the north-west, in the Kawarau Gorge, the rocks are chloritic and soft blue schist, lying west of the great anticlinal axis, and these underlying rocks are characterized by the occurrence of calcite, which is rare in the antimony-bearing rocks, and absent from the over-

lying rocks, which are grey foliated mica-schist, in which quartz laminæ are less abundant, and quartz reefs but rarely occur.

TERAWHITI GOLD MINES.

At the request of the shareholders, to whom his report was furnished, Mr. McKay made a further examination of the Terawhiti District, and reported on the Albion Mine, in which the prospectors have struck a reef 3 feet thick in their shaft, at a depth of 50 feet from the surface, underlying at an angle of 40°. At the 80-feet level a cross-cut was driven which intersected the reef, 2 feet 6 inches thick, 70 feet from the shaft, and it was then driven on north and south, some of the stone from this level being estimated to carry 4 oz. of gold per ton. A lower tunnel, 350 feet in length, which cuts the bottom of the shaft 123 feet from the surface and intersects the reef 170 feet west of the shaft, has been driven, and in this level also the reef has been followed north and south. The reef is flattening in the lower levels to an underlie of 30°; but in a winze sunk it was shown to have thickened to 5 feet, and to be more solid than in the higher levels. The reef is well defined, will probably average fully 2 feet in thickness, and, as far as yet opened, about 5,000 tons of quartz is exposed.

LANGDON'S MINE, GREYMOUTH.

He was next sent to Greymouth, to examine the antimony lode and quartz reefs at Langdon's Hill; and reports that, of the seventeen claims which have been taken up on this promising lode, only three were being prospected, work on the antimony lode having been stopped for some time, pending the result expected from 10 tons of ore shipped to England. At the Langdon's Extended antimony lode, which I previously reported on (Geological Reports, 1878–79), the 9-ft. lode has been driven on across the face of the slip till it has nearly nipped out, while in the face of the low cliff on the south it is less than 3 feet in thickness, and is thinner to the dip. The underlie of the lode is about 40° at the outcrop; but at a depth of 12 feet it becomes much steeper, without any improvement being visible in its character, or any increase of thickness. The adjoining rocks are pyritous sandstone on the hanging-wall, which is penetrated for a few feet from the lode by thin veins of stibnite; and a blue silky slate on the foot-wall, which has a peculiar knotted structure, resembling garnetiferous schist. Langdon's

Reef, which is 400 feet lower than that last mentioned, is being prospected by a new tunnel, at the end of which quartz has been struck which yielded 19 dwt. 12 gr. gold per ton. The rocks on the hanging- and foot-wall are the same as in the antimony lode. In the Albion Mine a new drive is being entered at a lower level, but the reef had not been struck. Quartz is visible on the surface at the Working Miners' and Wilson's leases, a sample of stone from the latter locality yielding 3 dwt. 6 gr. of gold per ton to assay.

Mr. McKay next reported on an antimony lode at Reefton held on lease by Messrs. Bayfeild and Anderson. It is situated about 800 feet above the valley of the Inangahua at Black's Point. The lode has not been traced on the surface; but the outcrop is 18 inches thick, with sandstone for the hanging-wall and pale-green silky slates for the foot-wall. A block of ore 6 feet by 6 feet was exposed near the outcrop. A drive was put in 150 feet along the hanging-wall, and a shaft sunk at the far end to a depth of 36 feet, stibnite being cut at a depth of 20 feet below the level of the drive, of much the same character as that at the outcrop. He considers that the ore occurs in bunches; but the work done was not sufficient to enable him to form any opinion as to the future prospects of the mine.

During April and May Mr. McKay was engaged on a geological survey of the Reefton district, and the collection of a large series of mineral and rock specimens for deposit in a local museum which has been established by Government for the guidance of miners. The following is an abstract of the geological features of this important mining district so far as they have as yet been ascertained. The Victoria and Brunner Mountains, which form the watershed between the Inangahua and Buller Rivers, are composed of granitic and metamorphic rocks, on which rest Devonian and Carboniferous strata, tilted at high angles and thrown into a series of anticlinal and synclinal folds, faulted, fissured, and filled with quartz reefs carrying gold and various metalliferous minerals. These Devonian and Carboniferous rocks form a range of hills along the east side of the Inangahua plain from Larry's Creek to Reefton, south of which they form the basement rock over a considerable extent of country in the direction of the Grey River, while at the northern end of the Inangahua Valley they are seen in the bed of the Buller River below the junction of the Inangahua. The next rocks in age which are met with are those in which the

coal-seams occur. They crop out on both sides of the Inangahua Valley, which is in a syncline, the coal being, in all probability, continuous throughout the flat. They are again found as outliers on the Carboniferous and Devonian rocks, and at places enter into the structure of the ranges. Besides these, younger Miocene or old Pliocene gravels occur as high terraces and low hills on the eastern side and southern end of the Inangahua Valley, and the remnants of widespread high-level gravels of younger date occur over the hilly south-eastern portion of the district, a yet younger series occurring before the recent river-gravels and fluviatile deposits of the Inangahua Plain are reached.

The granite and metamorphic rocks vary in character, as is evidenced by the wash in the river-beds, but *in sitû* they have been as yet examined in only few localities. In the Waituhi they occur as a fine-grained syenitic rock, forming hummocky bosses on the north bank of the river, and higher up a light-coloured granitic rock must be strongly developed. Boatman's Creek brings down but little granite-wash, and probably does not reach back to the granite belt; but in Larry's Creek the granite crosses the creek at a short distance above the Caledonian Mine, and the auriferous rocks have been considerably metamorphosed in the vicinity of it. At the upper end of the first gorge the granite is succeeded by schists, and at the junction of the creeks another narrow belt is met with, above which little granite is seen, and metamorphic rocks occur, which may or may not be the equivalents of the Devonian or auriferous rocks. Mr. McKay considers that the metamorphic rocks are mainly of Silurian age, on the ground that they are continuous with the rock formation at Mount Owen, at which point and northwards the schistose rocks are known to be Silurian. It is important to note that in the softer schistose parts of these rocks the auriferous reefs of the Lyell are being worked, and Mr. McKay considers it probable that gold will be found in these beds between the Lyell and Inangahua River at Reefton.

The fossiliferous rocks of the Devonian period, which I first described in 1873,* do not occupy a great surface area, being principally developed between Rainy and Murray's Creeks, and extending from there for some distance towards Boatman's, at which locality, however, they are never seen. At the southern end in Rainy Creek they disappear below the coal-rocks.

* Geological Reports, 1873–74, p. 85.

At Rainy Creek the width of their exposure is about a quarter of a mile, while to the north this increases, and on the southern bank of the Inangahua they are half a mile wide, and on the north bank of the Waituhi fully a mile in width. The rocks are cherts, limestones, and slates, the cherts occupying the lowest position; they are of various shades of grey, and sometimes red, while a higher bed in the sequence, overlying the limestone, is white, and more of a sandstone than chert. The lower limestone is a black bituminous argillaceous rock; the upper, which is interstratified with the slates, is massive, and of a light-grey colour, weathering to a brownish red. The slates are siliceous in their lower beds, becoming more argillaceous higher in the sequence, and close to the limestone a bituminous mudstone occurs. Slates, limestones, and cherts are alike fossiliferous.

Between the source of Lankey's Creek and the right-hand bank of the Inangahua the cherts attain an elevation of 1,500 feet to 1,800 feet above the river valley, and form precipitous cliffs where cut by the streams. The limestones also form high cliffs, while in Murray Creek the cherts are exposed as bare surfaces of white or light-grey rock sloping to the westward at high angles. The slaty beds do not assume such a bold configuration as the cherts and limestones, but more resemble the auriferous rocks which rest on them.

Hitherto the junction-line of these rocks with the auriferous series has formed the boundary of the reefs which lie parallel to the line of junction; but it is difficult to understand why reefs should not occur in the Devonian slate, as the character of the rock would be favourable for their occurrence.

The sections given* of the Devonian rocks show the sequence of the beds in different localities.

It is evident, from a study of these, that either the Devonian rocks in the upper part of Lankey's Gully pass below the auriferous series on the western side, or that the limestones have thinned out between that point and the junction of Coal and Murray's Creeks at Cement Town; and the presence of the red cherts, near the western junction, which characterize the lower division of the series renders the former alternative the more probable. Auriferous cements occur along the junction of the auriferous and Devonian rocks at Cement Town and the head of Lankey's Gully.

* Sections pp. 109, 110, 111, 118.

Mr. McKay is inclined to believe that these Devonian rocks are closely connected stratigraphically with the older palæozoic sequence seen farther north, where the fossiliferous Silurian strata can be traced downwards into mica-schists, the intrusion of the granite-porphyries here as in other parts of the West Coast district of New Zealand having taken place subsequent to the deposition of the Devonian rocks. Their mineral character is similar to that of the Silurian rocks of the Baton River and Wangapeka, fossiliferous cherts and blue calcareous slates occurring at the base of the one and the upper part of the other. It may be argued that either the Wangapeka cherts are identical with those at Reefton, or that the latter are overlying beds without break or unconformity. There are many fossils identical from the two localities, for a comparison of which the following table will be found useful:—

BATON RIVER.	REEFTON.
	Brachiopoda.
Not found.	A species of *Athyris* most abundant.
Chonetes. Beds formed of layers of this shell only.	Broad-winged mucronate Spirifer very prominent.
Spirifer, sp., identical with Reefton species.	Spirifer, sp.
Spirifera radiata.	Not found.
Rhynchonella. Two or three species poorly represented.	*Rhynchonella.* Two or three species poorly represented.
Orthis and *Strophomena* fairly represented, most species being same as at Reefton.	*Orthis* and *Strophomena* fairly represented.
	Lamellibranchiata.
	A few *Aviculidæ.*
	Gasteropoda.
Murchisonia, sp., same as Reefton.	*Murchisonia*, sp.
	Crustacea.
Trilobites. Same as Reefton.	Two genera of Trilobites, represented by one species each.
	Corals.
	Madrepore corals form the great feature of the upper limestone, some being as much as 2 feet in diameter.
	Polyzoa.
	Fenestella is abundant in the slaty and chertose beds.
	Crinoidea.
	Encrinites are abundant in the slaty and chertose beds.

Hitherto the Lower Devonian rocks have not proved to be rich in metallic minerals. A little galena is reported to have been obtained from the limestone in the Murray Creek saddle;

and quartz veins, a few inches thick, have been found, one in Lankey's Gully carrying a good deal of pyrites. As a building-stone the quartzites, although of good colour, are generally too hard for hewn work; but the limestones will prove of value to the district for building, &c., and as ornamental marbles the purer parts of the madrepore limestone will rival anything of the kind found elsewhere.

The auriferous series of Reefton as yet comprises only those rocks which belong to the Maitai or Carboniferous formation. This formation covers a considerable breadth of country between the Grey River and south branch of the Inangahua, but from Rainy Creek north the auriferous rocks are separated into two belts by the Lower Devonian strata, coming together again between the north branch of the Inangahua River and Boatman's Creek. In the bed of the Buller River auriferous rocks containing large reefs of white quartz are seen at the junction of the Inangahua.

At Larry's Creek the full breadth of these rocks is a mile and a half, while at Boatman's it is not less than three miles, and near Reefton they are two miles and a half wide, but rapidly become wider to the south of this. The rocks of this formation are not varied in character; they consist of gritty sandstones, coarse and fine, which, by the decomposition of one of their constituents, frequently assume a tufaceous character on the surface, and blue and pale-green slates interstratified with them, it being in these latter beds that the reefs are worked. In the higher part of the series diorites and calcareous diabases are found in which graphite occurs, both in the rocks themselves and in the reefs which traverse them. In the northern part of the district, at Larry's Creek, these rocks have been partially metamorphosed, while south of Reefton the character of the rocks is the same as in the vicinity of the township. In places the sandstones and slates are highly impregnated with pyrites, the rocks at the surface being stained to a deep ferruginous colour, and fibrous hæmatite deposited in thin veins of segregation.

The sections given* show conclusively that the auriferous series is not only younger than the Lower Devonian rocks, but that it rests upon them with a marked unconformity at all points where contact is made, and, moreover, at different points they rest upon

* Sections pp. 109, 110, 111.

different members of the Devonian sequence. The Reefton auriferous rocks closely resemble the lower part of the Maitai series as developed at Dyer's Creek, on the Motutapu track from Nelson to the Pelorus, the red slates of that locality which overlie the limestones not being present at Reefton. Green slates do not occur in any younger formation; but both at Reefton and Nelson these are prominent features. The Reefton rocks are identical in character with those at Langdon's Hill, Greymouth, and again on the coast twelve miles north of the Grey. They contain the fossil annelid which, with the *Inoceramus* found at the Dun Mountain and the Maitai River, is the only fossil yet found in these beds, so that the evidence on which these rocks are referred to the same horizon as the Maitai slates may be considered as sufficient.

The known mineral wealth of this series is confined to gold and antimony. Of the gold mines, a number are now steadily remunerative, and recent work has shown that, so far, the richest stone has been obtained from the greatest depths. The average yield of gold per ton of quartz crushed during the past year was 1 oz. 7 dwt., so that up to the present only the richest reefs can be worked; but as many mines have large bodies of stone, some as much as 30 feet thick, it is probable that before long quartz giving a less yield will be worked remuneratively. The reefs generally strike N.–S.; in the southern end of the field they underlie to the westward, but at Boatman's their underlie is to the east, and they are always standing at high angles. In the block of country between the two main branches of the Inangahua River there are three distinct groups of reefs running approximately parallel, and south of Reefton another must be added, since to none of these can be referred the Golden Point and Devil's Creek Reefs.

The most easterly of these belts, lying next to the Devonian rocks, and limited by the Phœnix and Inglewood claims on the north and the Golden Treasure on the south, is distinguished by the presence of stibnite associated with the auriferous quartz. The next to the west is that from Crushington across Murray Creek to the Golden Fleece, and is well known as the line on which the Wealth of Nations, Energetic, and Keep-It-Dark mines are situated. The most westerly belt on the north side of the Inangahua is that known as Anderson's line of reef, and has not been so fully developed as the other two. At Boatman's

there are two lines of reef, the Fiery Cross and Welcome line, and another, further to the west, which is as yet only being prospected.

Antimony occurs in the district, both as lodes of stibnite and in association with the auriferous reefs. That on the west side of Auld's Creek, leased by Malcolm and Bayfeild, contains no quartz except that which is disseminated through the ore: it strikes S. 25° E., and is nearly vertical or dips at high angles to the east. Quite as rich and more continuous deposits of antimony occur in many of the gold mines, as in the Souvenir Claim, Rainy Creek. Large quantities of antimonious ore are treated at the Welcome Mine and elsewhere by crushing in the ordinary manner and saving as much gold as can be accomplished by ordinary means, the antimony going to the tailings-heap or being washed away as the case may be. A great deal of gold is thus lost which ought to be saved by subsequent treatment of the ore, and the battery returns on the antimonious quartz make it appear to be of low grade.

Mr. McKay makes an important induction—that the reefs were formed prior to the principal syncline in the auriferous rocks, and that they were deposited prior to the coal formation, and so suffered considerable dislocation and crushing when these rocks were upheaved and elevated to their present position, so that these later movements may have broken the quartz reefs since the gold was precipitated in them.

The Cretaceous and Cretaceo-tertiary rocks, he states, form a continuous sequence, and, although there may occasionally be an overlap of the higher beds, in every case where the higher and lower beds are superimposed there is no stratigraphical unconformity between them. They crop out on either side of the Inangahua Valley, dipping towards its centre, and on the western side stretch back to the higher slopes of the Paparoa Range, apparently making connection with the coal fields of the coast-line farther south, while to the north they cross the Buller Valley into but partially explored country in the direction of the Mokihinui. The measures dip beneath the valley, and Mr. McKay states that they are without doubt continuous till they rise again on the western slopes of the auriferous range, although in the lower grounds the coal is probably at such a depth as to preclude its being worked for years to come. The eastern outcrop commences near the Buller River on the north and flanks the range between Larry's and Boatman's, but little

is known of it till the watershed of Boatman's Creek is reached. From Little Boatman's to the Waituhi the outcrop is continuous, and from there to Reefton is only broken or superficially obscured by younger deposits, while south of Reefton the coal rocks crop out between the auriferous rocks on the east and the Miocene gravels on the west of the valley leading to Devil's Creek.

Another coal-bearing area of considerable importance lies farther to the eastward, between the auriferous range and the western slopes of the Victoria Mountains. Its northern termination is not accurately known, but it is within the watershed of the upper part of Boatman's Creek, to the south of which it is found in the Waituhi, and forms mountains between there and the upper part of Garvie's Creek. A considerable outlier occurs in the upper part of Rainy Creek, and others yet farther south, between Rainy Creek and Big River. Two smaller areas are developed near the source of Murray Creek and the right- and left-hand branches of Lankey's Gully. The beds of this series consist of huge angular breccias, or breccias of finer material, conglomerates, quartzose grits, coarse- and fine-grained sandstones, micaceous and dark fine-grained shales or fireclays, associated with coal-seams. On these rest brown sandstones, succeeded by marly concretionary beds, usually of a dark colour. Above these lie gritty calcareous sandstones, followed by the more chalky beds representing the Cobden limestone. The auriferous cements which occur at the base of this formation, on the west side of the auriferous range, are of varying thickness. Gold has been found in them at Boatman's Creek, Murray's Creek, Coal Creek, Lankey's Gully, and Garvie's Creek; but, except in Coal Creek and Lankey's Gully, they have neither been worked nor much prospected for gold. The best-paying ground hitherto worked has been where large blocks of cement strew the spurs, and at a place called "The Island" 150 oz. of gold are said to have been obtained from an area about 1 chain square. Small quantities of cassiterite have also been found in these rocks.

In the coal-bearing rocks seams of coal occur from 4 to 10 feet thick on an average, and the seam worked by the Golden Fleece Company at the head of Murray Creek is from 30 to 40 feet in thickness, specimens taken from the south drive being of a bituminous character, and yielding a hard coherent coke.

The Upper Miocene gravels, he states, are chiefly seen on the

eastern side and southern end of the Inangahua Plain. Between Larry's Creek and Reefton they form the higher terraces and first hills skirting the plains on that side, while south of Reefton they form the hilly country between that place and Squaretown, and from the latter place stretch south along the east side of the Little Grey. The beds are mainly composed of waterworn gravels derived from various rocks, and, though generally coarse, beds of finer material are of frequent occurrence, and seams of lignite are interstratified with them; they are at many places auriferous, and several sluicing claims have been taken up in them.

The Pliocene gravels have at one time been spread over the high levels of the southern part of the district, but are now in great part removed by denudation. Beds belonging to this formation lie round the source of Soldiers' Creek, and cap the hills between there and the fall to the Inangahua opposite Reefton, and the coarse drifts worked for gold at Merry-Jig are also probably of this age. The recent beds cover the low ground and fill the river-beds of the district, forming marginal terraces, which rise on the sides of the narrow parts of the river valleys, and some of them also are probably of lacustrine origin.

JAMES HECTOR,

Director.

20TH JULY, 1883.

THE DISTRICT AROUND NORSEWOOD.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

3rd January, 1882.

I HAVE the honour to inform you that, in accordance with your instructions, I have visited the Norsewood district, and examined the works which have been carried on in the search for coal, and herewith submit the results of my examination.

On the eastern flanks of the Ruahine Range, west of Norsewood, rocks consisting of coarse sandstones and grits interbedded with shales occur, striking about N.E., and having a high easterly dip. These rocks frequently contain numerous impressions of broken plants, but not in such a state of preservation as to afford any opportunity of recognizing them and determining accurately their age. The rocks, however, bear a strong resemblance to those which in the Wellington Province have been considered to be of Triassic age, and as such they will have to be regarded until the opening-up of the country renders a more complete examination a matter of possibility. At present the dense character of the bush renders an examination in detail of these beds one of extreme difficulty.

Pliocene.—Resting unconformably upon the last-mentioned rocks come a series of beds which are known as "the pumice sands and lignite series," and these stretch for a considerable distance through the country. In travelling along the road from Eketahuna in the direction of Woodville, they are first seen after crossing the Mangatinoko River, where they are resting upon the shell limestones of the Manawatu Gorge; and, with the exception that they are overlaid by certain high-level gravels or subangular conglomerates over a considerable area (where they are only seen in cuttings on the roads or the steep gullies which have been worn away by the streams), and also that at places they are obscured by recent deposits (as around Woodville), they are continuous until Norsewood is passed.

In section they consist of—

1. Brown sands.
2. False-bedded pumice sands.
3. Conglomerates.
4. White pumice sands and fine quartz sands.
5. Sands and clays, with lignite.
6. Conglomerate.
7. Blue sandy clays, with indistinct fossils (all broken).

In character these beds have marked equivalents at various parts of the North Island. For instance, the clays and sands in which the lignite occurs are identical in character with the plastic

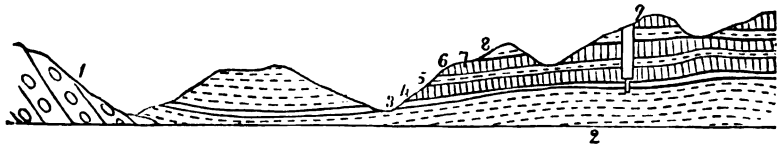
clays and sands of the Lower Waikato basin, while the brown sands and upper beds generally meet their exact equivalents around Tauranga, and between Opotiki and Katikati, where they rest at places upon much older rocks.

It is in these beds that the prospecting for coal has been carried on near Norsewood, and I regret to be unable to hold out any encouragement to the prospectors of success attending their work.

The works which have been carried on are as follow:—

In the bed of the Mangatewainui Stream two seams of an inferior lignite have been struck, each 3 feet thick, and separated by a parting of fireclay also about 3 feet in thickness. About 50 feet higher in the sequence, another seam, also about 3 feet thick, is seen cropping out near the summit of a cliff.

The dip of these seams is about 20° N.W., or about the same as the face of the hill. On a spur a short distance back from the creek a shaft has been sunk for a depth of 75 feet, and a bore-hole put down from the bottom of this a further 25 feet: in this bore two seams of lignite were struck, reported to have been 4 feet and 5 feet thick respectively, and separated by about 3 feet of clay; it is probable that these correspond with the lower seams cropping out on the banks of the Mangatewainui Stream. The rock which was got out of the shaft consisted of sand and blue sandy clays, which in many cases were full of broken remains of plants, but no recognizable specimens were amongst them. The following sketch-section will serve to illustrate the position of the beds:—



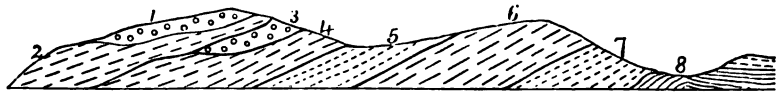
Section of lignite-beds at Mangatewainui Stream. 1. Sandstones, grits, and shales, with broken plants (Triassic ?). Lignite series, including—2. Blue sandy clays; 3. Lignite 3 feet, fireclay 3 feet, lignite 3 feet; 4. Sandy clay, with broken plants; 5. Fine quartz sand; 6. Sandy clay, with broken plants; 7. Lignite, 3 feet; 8. Sands and clays. 9. High-level subangular gravels.

At the outcrop of lignite in the Mangatewainui Stream the dip of the beds is to the N.W., or towards the high range which is not more than half a mile distant, so that a syncline must occur between these two points.

Between this outcrop of lignite and Ormondville but very little is to be seen save the high-level gravels, but at one or two places the lower beds are met with, and especially where streams have cut through these overlying beds and formed gorges through the lignite series.

In the vicinity of Ormondville several cuttings have been made

along the line of railway, and all of these pass through the same beds, the following being a typical section:—



Section in cutting near Ormondville. 1. Conglomerate. 2. Clays and sands. 3. Conglomerates. 4. Blue clays. 5. Yellow sands. 6. Marly clays (broken fragments of shell). 7. Pumice sands and clays, with thin seam of lignite. 8. Sands and clays.

The creeks here cut some 200 feet deeper into these strata, exposing sands and clays down to their beds, and I am credibly informed that thick bands of lignite have been found at various places in these creeks, although I did not myself see anything more than 1 foot in thickness.

Having now alluded to the formation of the country in this district, I will now briefly call your attention to the value of the discovery at Norsewood from a commercial point of view. The specimens of lignite which I brought from the drive on the banks of the Mangatewainui Stream are of very inferior character, as may be seen from the accompanying analyses:—

	No. 1.	No. 2.
Fixed carbon	9·04	7·81
Hydro-carbon	12·40	18·06
Water	33·98	19·69
Ash	44·58	54·44
	100·00	100·00

and there is very little probability of any one burning it from preference when they could get wood in large quantities, as is at present the case in the district. For locomotive purposes, moreover, it would be useless.

The works which have been undertaken are situated about seven miles from the railway, and, although in a position which could readily be reached by a tramway, would have no immediate value, seeing that the same formation stretches down to and for some distance past the railway line, so that, even were the lignite of good quality, supplies could probably be obtained in a far more convenient position than the one selected.

The real work of any value which has been done is simply a drive of 10 feet which has been put in at the face exposed in the Mangatewainui Stream, for the shaft was a quite unnecessary piece of work, and one which gave no further information than that obtainable at the surface.

With regard to the quality of the lignite, I may mention that an impression appears to exist that depth only is required to make it turn into a good coal, and it is on these grounds that the work of prospecting has been undertaken. It is as well to mention

here that there is not the least probability of any material change taking place in the character of the seams as they are driven on, and that all fuel likely to be obtained from the formation that is being worked is lignite, and that only of an inferior character.

GOLD FIELDS OF THE CAPE COLVILLE PENINSULA.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

INSTRUCTIONS BY DR. HECTOR.

Wellington, 4th January, 1882.

THE chief object I wish kept in view in your work for the remainder of this season is the determination of the essential geological and petrographical conditions that control the distribution of the auriferous lodes in the Cape Colville Peninsula, from Coromandel to Te Aroha. As you are aware, most conflicting opinions prevail on this point, and on the results of a correct study of the question must depend the selection of the measures that are required for the future development of mining enterprise in the district.

The best lodes undoubtedly occur in what has been described as a tufaceous rock, *i.e.*, a coarse- or fine-grained formation of igneous fragments. These are most highly auriferous when in the vicinity of outcrops of slate and sandstone rocks, and when the tufaceous character is due to superficial decomposition of highly indurated and metamorphosed masses. The question is this: Are these masses merely locally-altered portions of the great volcanic (trachytic) formation that is widely spread over the area between Taupo and the Bay of Plenty, or are they outcrops of a more ancient igneous formation?

Keeping this in view, you will, as far as time permits,—

1. Ascertain the relation of the slates to the tufaceous rocks on the east side of the Thames Valley;

2. Re-examine the typical section at Coromandel through Beeson's Island and Tokatea to Kennedy's Bay;

3. Study the junction which the breccias make with the slates at Tapu Creek;

4. Examine and compare the superficial with the deep workings at Shortland, and the relations of the containing rock-formation to that of the high country to the eastward, which has not yet been shown to be auriferous; specially ascertain if the auriferous belt overlies or passes under the rocks of the back ranges; and, if possible, select favourable positions for testing the extension of the auriferous area by means of the diamond drill;

5. Determine the structure of Te Aroha Range, which, so far

as is known, appears to consist of an andesitic or trachytic mass, flanked on the east by a belt of auriferous country;

6. Examine the relations, extent, and value of certain seams of bituminous coal that are reported to occur south of Coromandel, from which specimens were sent last year by the Hon. Mr. Whitaker.

General.—In the above work you will endeavour as much as possible to improve the geological mapping of the district, and to obtain information that will be of practical use for the guidance of miners. It is very desirable that all facts stated in your reports should be supported by the collection, for future reference and study, of rock specimens 3 in. × 2 in., located on your map and sections by distinctive numbers.

Narrative.

Wellington, 10th June, 1882.

I have the honour to inform you that, in accordance with your instructions herewith appended, I left Wellington on Thursday, the 5th January, arriving in Auckland on the 8th, and left again for the Thames on the 10th. From that date until the 28th January I was engaged at the Thames examining the various mines and surface-workings; and on the 28th I left for Paeroa. I remained in the Ohinemuri District until the 3rd February, visiting during that time the workings at Owharoa, Waihi, and Waitekauri; and from the 3rd to the 8th February I spent the time on Te Aroha Field, examining the recently-discovered gold-bearing reefs, and also acquiring a knowledge of the geological structure of the country. On the 9th February I returned to the Thames, visited the Queen of Beauty Mine, and on the 13th went to Waiomo with Mr. Workman, and on to Tapu the same night. On the 14th I went round the claims at Tapu, and on to where the reported discovery of coal occurs up the Mata Creek, returning to the Thames on the 15th, and to Auckland on the 16th.

From the 19th to the 27th February I was engaged in the inspection of the coal mines in the north, and from that time until the 7th March I was employed on the Coromandel Gold Fields. I returned to Auckland on the 8th, and thence returned to Wellington, arriving on the evening of the 12th March.

Report.

I propose, in reporting on the district which I have examined, to divide my subject under two main heads: I. The Geological Structure of the Country; II. The Character of the Reefs, with a description of those points which appear to have more or less regulated the distribution of the gold.

I.—The Geological Structure of the Country.

XII. *Lower Carboniferous and Upper Devonian Rocks.*—The

Cape Colville Peninsula consists of a belt of slates which stretch from Tapu Creek to the Matawai at Coromandel, being overlaid at places by one or other of the formations which have yet to be described. They crop out again in the lower parts of the gullies cut by the creeks which fall into Cabbage Bay, and are seen as a small patch near Tararu Point, at the Thames; they are also mentioned by Dr. Hector* as cropping out on the shores of the Bay of Plenty near Waihi. It thus appears that these slates form the basement rock of the district under consideration, and they will doubtless be found at many points in the interior of the peninsula, occupying the low ground cut by the creeks, when these areas have been further opened up. It is of great importance, in studying the various gold fields throughout the district, to bear in mind the foregoing fact; and more especially is it essential for us to remember that, although at places—*e.g.*, Thames, Te Aroha, Waitekauri, and Owharoa—the auriferous reefs are in a country which does not appear to have any direct connection with the slate formation, yet at no very great depths these rocks are certain to occur, and the question of whether the auriferous reefs will ever be found payable in them is one on which the eventual prosperity of the gold fields will largely depend.

The slates are of a green, blue, or brown colour, and fine-grained; they are in many cases very hard, as at Tapu and Matawai; and they are interstratified with sandstones. At Tapu the main strike of the slates, as seen at the back of Mr. Pepper's battery, is N.–S., with an easterly dip of 60°. They can be traced up the creek from just above the bridge to Number Five Gully, and extend through the range between the Tapu and Mata Creeks, in which latter they occur for some distance along the lower part of its course, and then strike across to the coast, which I understand they follow for the greater part of the way to Coromandel. In the Matawai the strike appears to be about N. 15° W., with a westerly dip at high angles; and at Waiohanga, near Tararu Creek, the strike is N.W., and the dip S.W. at an angle of 35°; a bed of felsite which overlies them there having the same strike and dip.

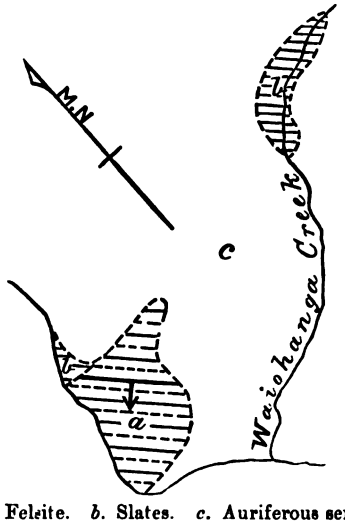
These are the only points at which I have observed the strike and dip of these beds; but there are a few points in connection with them which require to be carefully noted, the most important being the occurrence of a pyritous felsite at several places in intimate connection with the slates.

What absolute relation these felsites have to the slates I am not prepared to say, for, although I was constantly on the look-out for information, I found no opportunity of placing the matter beyond doubt. Captain Hutton† mentions the occurrence of a

---

* Geological Reports, 1870-71, p. 102.
† Geological Reports, 1868-69, p. 18.

felsite at Waiohanga alongside the slates on the beach, but states that it does not appear further up the creek where the slates are again seen, and argues from this that the felsite is an intrusive mass. The statements he makes I can quite bear out, but, as the strike of the rocks (N.W.) would carry the felsite away in the direction of the Thames and not up the creek, it is probably obscured by the overlying unconformable formation of which the surrounding country is composed, and may thus be a stratified rock, the slates cropping out higher up the Waiohanga Creek being a parallel belt.



a. Felsite. *b*. Slates. *c*. Auriferous series.

This is illustrated by the above sketch, which shows the position of the different outcrops, and is taken from Captain Hutton's map of the district.

At Tapu Creek, up Number Two Gully, a very similar rock is met with, close to which a little gold has lately been obtained; and here again it is in close juxtaposition to the slates. It may seem a matter of small importance whether this particular bed is or is not associated with the slates; but this is not the case, for, when we come to visit Coromandel, we find that in the Tokatea drive this same rock has been met with and passed through, striking N. 15° W., and dipping to the westward at an angle of about 50°, thus corresponding in strike and dip with the slates of the Matawai Creek.

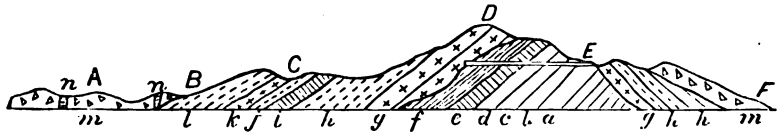
It is moreover, in this locality, interstratified with rocks which, in the drive where they are undecomposed, very closely resemble the slates, while on the surface it is very difficult to recognize them owing to the occurrence of decomposed volcanic rocks, which belong to the auriferous series of the Thames, and partially obscure them. The rocks in which the gold occurs in the Tokatea

tunnel are of a more earthy character, and softer than the slates which are exposed at the surface in the localities previously mentioned.

Notwithstanding the difficulty of correlating the surface rocks of the Tokatea Range with those which are met with in the tunnel, it appears equally unreasonable to consider them as the equivalents of the auriferous series of the Thames, which I shall presently describe; neither do they resemble any auriferous rocks which I have seen elsewhere throughout the peninsula.

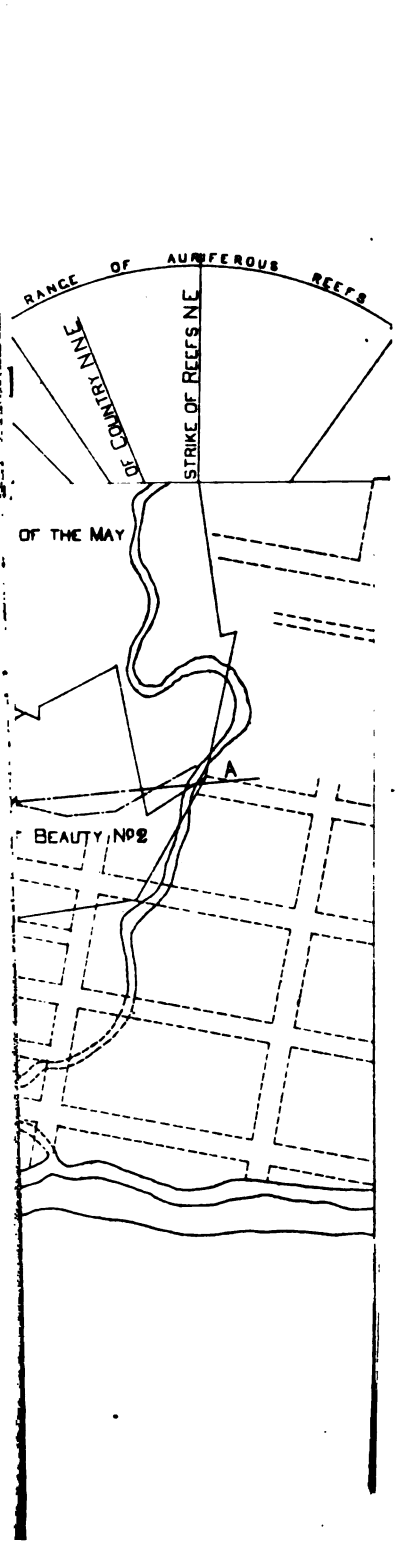
On the upper part of the Tokatea Range, however, where the Bismarck Claim is situated, and between there and the Union Beach Mine at Coromandel, rocks occur which are distinctly volcanic in character, and which do not appear to have their counterparts in the low-level tunnel which I have mentioned. This leads me to suppose that the lower workings at least of the Tokatea Mine are in a different formation from what the whole of the Thames workings are in, my view of the matter being borne out by the different character of the rocks, the dip of the country, and the fact that the felsite is associated with the gold-bearing rocks, which do not materially differ from it except in their degree of hardness, being softer and more readily worked. Whether the rocks of the Tokatea Mine are allied to the slates I am not prepared authoritatively to state, but think that such is the case; and I believe the points which have been observed will tend to confirm this view of the matter.

The following section from Kennedy's Bay to Beeson's Island will explain the above notes:—



Section from Beeson's Island to Kennedy's Bay. A. Beeson's Island. B. Union Beach. C. Kapanga Mine. D. Tokatea Range. E. Tokatea Tunnel. F. Kennedy's Bay. *a*, *b*, *c*, *d*. Hard and soft bands of calcareous slate, with veins of calcite. *e*. Close-grained compact felsite. *f*. Earthy slates (auriferous). *g*. Diorite porphyry. *h*. Tufaceous sandstone. *h'*. Brown sandy rock. *i*. Diorite porphyry. *j*. Tufaceous sandstone. *k*. Decomposed diorite porphyry. *l*. Tufaceous sand. *m*. Coarse trachydolerite breccias (Miocene?). *n*, *n'*. Anamesite dykes traversing *m*.

Auriferous Rocks of Thames.—(Age?) The next series of rocks, in ascending order, which are met with in the Cape Colville Peninsula, are those which carry the gold-bearing reefs of the Thames and other gold fields of the district; and I devoted some time to the study of these rocks at the Thames, where the large amount of work done affords opportunities, not elsewhere obtainable, of testing whether or no one is correct in any views which may be formed.


RANGE OF AURIFEROUS REEFS
STRIKE OF REEFS N.E.
OF COUNTRY N.N.E.
OF THE MAY
Y
A
BEAUTY No2

This series consists of alternations of various kinds of volcanic rock, the lowest visible ones of which are the Hape Creek breccias, which consist of angular fragments of a purple and green colour, coarse- or fine-grained at different points, the whole being cemented in a tufaceous matrix. These beds have evidently undergone a considerable amount of decomposition, the felspars which form a large part of the rock being all changed; but this decomposition has not been due to surface weathering, as is evidenced by the presence of large quantities of pyrites in a perfectly undecomposed state, and also by the fact that at the bottom of the Queen of Beauty shaft, 540 feet from the surface, the same rock is met with, not differing in any way from that at Hape and Karaka Creeks. The same remarks about decomposition apply equally well to each of the numerous beds which overlie the breccias, and which are all more or less charged with pyrites, notably in the vicinity of the reefs.

These breccias are overlaid by a fine-grained felspathic pyritous rock, the "sandstone" of the miners, which occupies the whole thickness to the surface in the Queen of Beauty Mine; and above this, I am informed, alternations of different classes of country occurred through the Crown Princess and Prince Imperial Claims, which, as the mines were abandoned, I have not had the opportunity of examining. The next bed met with in ascending order which we can carefully examine at present is a hard green felspathic rock (54) found at the bottom of the Waiotahi main shaft, 300 feet from the surface: this rock has a dioritic appearance, but seems to be mechanically formed. Above this is a belt of the so-called "kindly sandstone," and then a band of what is known as "jointy or shingly country" occurs, and consists of a fine-grained light-brown rock which is much shattered and traversed by joints in every direction. Over this again another belt of the "good sandstone country," similar to that described in the Queen of Beauty Mine, occurs, and, through this, numerous thin black veins (which are probably a protosulphide of iron) may be seen traversing the rock in all directions, especially in the vicinity of the reefs.

In the Cure Mine, towards the Waiotahi boundary, another belt of hard green rock (29), similar in character to (54), comes in, and in its neighbourhood very varying classes of country are met with. At some places it is the "good kindly sandstone country," at others "shingly ground," and at others again the rock could not be distinguished in hand-specimens from the best class of rock, but is more jointy, and for some reason or other does not appear to have been kindly for gold. This belt of hard green rock comes to the surface on the Waiotahi Lease, and dips through the Manukau and Cure Claims, passing from these through the lower levels of the Golden Crown; the rock met with at the bottom of the shaft 170 feet from the surface being the same but slightly

decomposed, and more of a grey than a green colour; it is met with again in the Caledonian Claim at the 350-feet level, and from there passes into the lower levels of Tookey's Claim, it being the upper part of this belt which cut off the gold in the Caledonian reef when it reached the boundary of Tookey's Claim.

Above this again the rich belt of "sandstone country" in which the Caledonian reef was worked occurs, and passes through the upper levels of the Manukau to the 170-feet level of the Golden Crown and the 350-feet level in the Caledonian; from which point leaving the reef, in consequence of the dip of the country being at a less angle than the underlie of the reefs, it passes through Tookey's Mine above the 400-feet level, and from there dips into the Kuranui Hill and Moanataiari Leases, where, owing to all the workings having been shallow, it has not been proved. A barren belt comes in above this and cuts off the gold in the Moanataiari Mine at the 70-feet level on the south-east side of the main tunnel, it being close to this level that the last rich patch was obtained; and from this point in ascending order through the Kuranui Hill Mine the country has frequently changed its character, and the reefs have been correspondingly patchy, no *shoots* of gold having occurred to the north-west of the tunnel, and the horizontal extensions of the patches having only varied from 30 feet to 40 or 60 feet in length, and these have only been traced to a depth of 30 feet below the tunnel level.

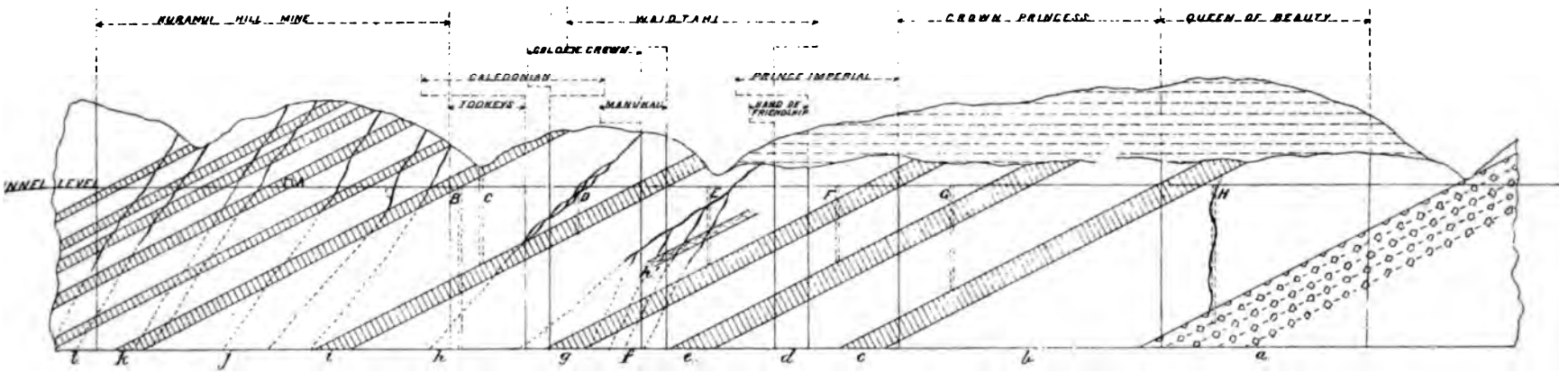
The section which faces this page illustrates the position of the various belts of good and inferior country in relation to the reefs which I have just described, but it is necessary to draw attention to those points which are fixed by absolute observation and those which are only inferred. The bed *a* is met with on the surface at Karaka Creek, and at the bottom of the Queen of Beauty shaft; *b* is met with from top to bottom of the Queen of Beauty shaft; *c*, *d*, *e*, and *f* are hypothetical beds which I have put in as illustrating how the gold has probably been cut off at the depths of 400 feet and 280 feet in the Crown Princess and Prince Imperial Claims respectively, these figures having been furnished me by Mr. George Wilson; *g* is met with at the bottom of the Waiotahi shaft; and *h* is the country generally met with in the Waiotahi Mine, the small patch *h'* representing the shingly ground in this mine by which I first managed to accurately obtain the dip of the beds, and on which this section is set out (this rock is again met with in the drive for the Central Italy shaft, in the Nonpareil Claim); *i* is met with in the 350-feet level of the Caledonian, the 200-feet level of the Cure, the 170-feet level of the Golden Crown, and crops out on the surface in the Waiotahi Creek; *j* is a well-known belt in the Caledonian, Cure, Golden Crown, and Manukau Claims, while those belts which overlie this have not been accurately mapped, but appear best to explain the patchy distribution of gold in the Kuranui Hill Mine.

Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.

THAMES GOLD FIELD

TO ILLUSTRATE REPORT BY S. HERBERT COX.



SECTION ON LINE AA SHEWING RELATIONS OF REEFS TO BEDDING

A. MOANATAIARI LONG DRIVE B. BIG PUMP SHAFT C. CALEDONIAN SHAFT D. GOLDEN CROWN SHAFT

E. WAIOTAHI SHAFT F. PRINCE IMPERIAL SHAFT G. CROWN PRINCESS SHAFT H. QUEEN OF BEAUTY SHAFT

The section of country which I have thus described is that in which the most important lodes hitherto worked on the Thames Gold Field occur, and it is to be observed that, although there are hard belts of country in this area (which is bounded on the north by a large slide or fault, following more or less an E.–W. course), no rocks are met with which could be considered as dykes.

To the northward of this slide, which is marked on the surface by a depression crossing all the spurs, and the outcrop of which in the Moanataiari Creek is only at an altitude of 200 feet above sea-level, a very different-looking class of country is met with, which has chiefly to be studied on the surface, in the Alburnia and New North Devon Mines, and in the Moanataiari long tunnel, as but few claims are at present working elsewhere. This difference in character is however only due to the greater hardness of the rock, and to the fact that those agencies which have shattered and subsequently decomposed the beds lying to the southward of the main slide have not exerted their influence to the same extent on the northern side; and this is the more remarkable since those to the southward are lying at a lower elevation, and are indeed principally developed below the level of the sea. The bearing of this fact will be particularly evident when I come to discuss the question of the reefs.

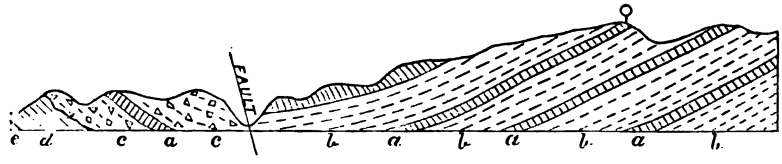
The approximate strike of the rocks to the southward of the slide is N.N.E., and they are dipping W.N.W. at an angle of about 1 in 2 so nearly as I can determine by the observations it is possible to make. The rocks to the north of the slide do not appear to differ from these either in strike or dip.

Several hard dioritic belts of rock may be traced on the surface in this area, and have been cut again in the workings to which I have alluded. One of these can be traced from the edge of the main slide, close to where the Moanataiari winding-engine is situated, up the Moanataiari Creek, which it crosses at the upper end of the Dauntless Claim, and from there passes through the spur to the Luck's-All Claim, and thence to the upper part of the Waiotahi Creek; another closely follows the ridge between the Moanataiari and Shellback Creeks, passing to the south-east of the trig. station on the New North Devon Lease, and both of these belts have been cut in the Alburnia Mine. A third belt, lying to the south-east of these two, is met with in the eastern cross-cut from the Moanataiari tunnel, and crops out at the surface in the Waiotahi Creek, where it forms the walls of the big reef for some distance, and, crossing the creek, rises the spur on the south-east side. Yet another belt can be traced at the Tararu Creek end, where it is seen occurring as disconnected patches on the tops of the spurs on each side of Tinker's Gully, looking on the surface like parallel dykes; but the creek itself having cut through a somewhat softer class of country, in which some remunerative workings have been situated, proves that these are not the outcrops of dykes, but parts

of a belt which is lying parallel to the bedding of the country. Interstratified with these hard bands are belts of more kindly country in which the auriferous workings have been carried forward, and have at places, as in the Alburnia, proved highly remunerative.

The dip of the beds between the Tararu and Waiotahi Creeks is constant to the W.N.W., at an approximate angle of 1 in 2, flattening somewhat as Tararu Creek is reached, which would give a thickness of over 2,000 feet of strata in this section above the belt of hard rock in the Moanataiari cross-cut. On the north-west side of the Tararu Creek, near its mouth, a coarse breccia similar in character to that at Hape Creek occurs, and this can be traced for a long distance up the creek, which it crosses at places, it being in the same formation that the Little Agnes Claim, up the Ohio Creek, is situated. The late E. H. Davis, in his Report on the Thames Gold Field (Geological Reports, 1870–71, p. 56), has very carefully described the characters of this rock as seen in Tararu Creek, and he estimates its thickness at 150 feet (*l.c.*, p. 58), but I should consider the total thickness to be a great deal more. The dip of the rock interstratified with it in Tararu Creek is S. 60° E. at an angle of 15°, and the breccia turns up against the outcrop of slates and felsite at Waiohanga Point. This bed does not appear to be represented in the section between the Moanataiari and Tararu Creeks, and the evidence of the section on the southern side of the Moanataiari main slide is to place it at the base of the auriferous series so far as at present proved, a position which it must occupy here since it rests upon the basement rock of the district.

Under these circumstances, the only way of accounting for its occurrence at Tararu Creek is by a fault traversing the country in a north-east direction from the mouth of the creek, which would bound these breccias accurately as far as the Little Agnes Claim, beyond which point I am not acquainted with the country. I have accordingly shown this fault, which would have a throw of not less than 2,000 feet, in the following section :—



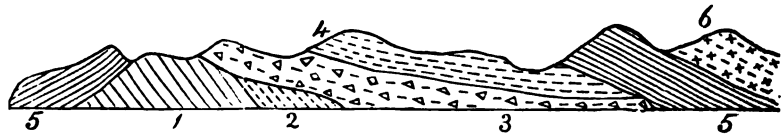
Section—Waiohanga Creek to New North Devon trig. station. *a*. Hard belts of dioritic rock. *b*. Decomposed tufaceous rock (sandstone). *c*. Breccia. *d*. Felsite. *e*. Slate.

It is sufficiently remarkable that this line of fault is parallel to the lines of fracture of the principal auriferous reefs, with which it is probably contemporaneous.

To the north of Waiohanga Point until reaching Tapu Creek

the strike of the beds varies from E.N.E. to N.E., and the dip from S.S.E. to S.E., all at low angles, the strata consisting of alternations of hard and soft bands of rock until Waiomo is reached. At this point, where some workings have lately been started, the country, which is of a sandy nature, is banded and strikes E.N.E., dipping S.S.E. at flat angles, but waving slightly; overlying which and preserving the same strike and dip another of these hard bands is met with, differing in no degree from those of the Alburnia and Moanataiari. It occurs capping the spur on the northern side of the creek, and descends to the creek level on the southern side, while in the direction of the Thames it is overlaid by a light-grey decomposed felsitic-looking rock. Between Waiomo and Tapu Creek very little change takes place in the character of the rocks, which consist chiefly of a jointy decomposing tufaceous formation, with (at a point near Tapu) a thin band of lignite of very inferior character interstratified with them. Up to the present time no gold has been obtained from these rocks, and it appears probable that the series belongs to a younger formation, which lies on the western side of a belt of slates at this point, and corresponds with certain rocks which I shall have to mention further on.

At Tapu, on the north side of the creek, there is a belt of auriferous country overlying the slates on the western side of Number One Gully, and this belt extends into Number Two Gully, it being partly in this formation that the Great Republic Claim was worked, and also that the present patch of gold has been obtained by Bowden and party. There is, however, a belt of felsitic rock represented in this district which very closely resembles that found at the Waiohanga Point, and which I am inclined to regard as related to the slate formation. The slates are met with in the Great Republic Claim, and I am informed that the reefs were traced down into these, and also that they carried gold, but the reefs were pinched and the country was so hard that the workings were very soon abandoned. These slates can be traced up the creek from just above the bridge to Number Five Gully, where they are overlaid unconformably by a belt of hard rock and breccia, which in places resemble the Hape Creek breccias, and at others are far more like those belonging to the Miocene formation, to which, however, they cannot belong. Overlying these beds, in which, by the way, reefs occur, but have never yet proved very highly auriferous, a belt of softer country is met with, and in this the principal auriferous workings have been carried on. The dip of these beds is S.E. at low angles, and they are capped again by a harder belt of rock. The auriferous belt may be traced across the country from Tapu Creek to Mata Creek, in which it is found as high up as Gentle Annie Creek, but above this point no gold has as yet been found, and the younger Miocene breccias come in with thin seams of coal.



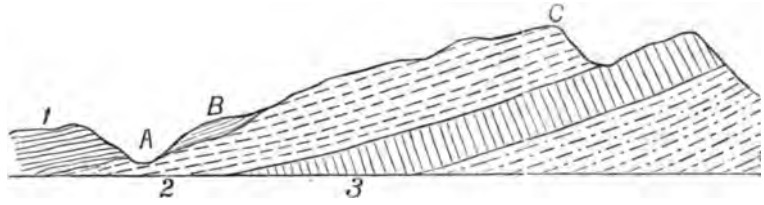
Section up Tapu Creek. Lower Carboniferous, or Upper Devonian: 1. Slates; 2. Felsites of Annie Creek. Auriferous series: 3. Hard rock and breccia; 4. Soft tufaceous sandstone. Lower Miocene: 5. Tufaceous marls and breccia, with coal; 6. Breccia-beds with coal.

Passing again to the southward of the Thames we find the auriferous series of rocks retreating from the western side of the range, which they occupy at that place; when Tairua is reached they form the body of the main range with the Puriri rocks flanking them to the westward. The country between Tairua and Waitekauri is practically unknown, but it is probable that the same belt of rocks is continuous throughout, although it may be capped at places by the younger series. When we arrive at Waitekauri we find a similar class of country to that represented at the Thames, although somewhat coarser-grained rocks appear to have been the matrix of the gold here. The strike and dip of the beds both at Waitekauri and Owharoa have changed, but they are still lying at flat angles, and information is more readily obtainable here concerning them than at the Thames, or possibly, having, before visiting this locality, gained some insight into the stratification elsewhere, it appeared simpler to me.

At Owharoa the Smile of Fortune and Radical Claims are being worked in the same belt of what the miners call "good" sandstone country, and these have hitherto proved the most remunerative mines in the district. This country is rather coarser-grained and more gritty than the auriferous country of the Thames, and is traversed by "flinties" (small veins of cherty quartz) instead of the black veins I have previously alluded to, and they appear to affect the auriferous reefs in the same way. This belt of country runs through the Battalion ground to the westward, and through the Golden Hill and Bank of New Zealand ground to the east. It is overlaid unconformably by a belt of pumiceous clay, which has been taken for a slide, but which I shall refer to again when treating of a younger formation. The auriferous series again crops out close to the southern side of the Ohinemuri River, being overlaid there by a hard belt of porphyry, which passes into dolerite at places.

Below the auriferous belt of the Smile of Fortune and Radical Claims a hard belt of country comes in which has recently been struck in a drive put in by the proprietors of the Lucky Hit Claim, and it is also met with in the Radical Ground, a similar rock occurring up to an elevation of about 500 feet at Waitekauri, from which point it dips towards Owharoa, forming the basement of what has yet proved auriferous country. It will doubtless be

found, if this rock be sunk through, that another belt of auriferous country underlies it.



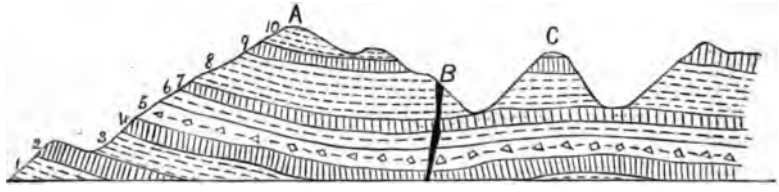
Section—Waitekauri to Owharoa. Pliocene: 1. Pumiceous clays. Auriferous series: 2. Coarse-grained tufaceous sandstone; 3. Hard green dioritic rock. A. Ohinemuri River. B. Owharoa. C. Waitekauri.

Between Owharoa and Waihi a belt of hard green rock (71) crops out, in which decomposition has frequently set in concentrically. Over part of the road the rock is not visible, but a red-coloured soil points to the fact that it is underlying. It is probable that this hard belt of rock is to be found at no great depth all along this line, and that the pumice sands and clays, which overlie it unconformably, lie away to the southward on the plain. This belt of hard rock may be traced from the road-line or just on the other side of the creek up to the Waitekauri, where, as previously mentioned, it crops out at an altitude of 500 feet and underlies the auriferous belt which can be traced from Waitekauri to Owharoa and occurs as isolated patches along the strike of the beds between there and Waihi, but at Waihi the country is of a softer nature, although still fair standing ground.

The strike of the rocks at Owharoa and Waitekauri is about E.–W., with a southerly dip; while at Waihi the strike is more nearly E.N.E., and the beds syncline as shown on the plan.

At Te Aroha again the geological structure of the country is of great interest, more especially because, on Dr. Hochstetter's authority, the mountain was originally considered to be an extinct trachytic cone. As a matter of fact it is nothing of the sort, but consists of a series of regularly stratified volcanic rocks, which are continuous through the mountain itself and the adjoining ranges, not differing in any way from those which have proved auriferous at the Thames and elsewhere. On the south-west side of Te Aroha range, near where the Wairongomai River debouches on to the plain, a belt of soft country occurs, in which a little gold was formerly got. Above this, a belt of hard greenish rock, perhaps 100 feet thick, is seen dipping to the N.E. at an angle of about 20°; and, above this, a belt of banded country, some hard and some soft, crops out, in part of which the old Shotover workings were situated. This belt would sweep round the hill to near the Te Aroha Township, a belt of hard brown rock, partially decomposed, overlying it; and in this belt the original prospectors' claim was opened. Above this belt again comes a bed of purple and

green breccia, which closely resembles the Hape Creek stone, and this is passed over on the mountain track. It is in this breccia that the galena and blende lode, the property of Mr. Allen, occurs; and it will be remembered that it was the same class of rock which formed the matrix of the mineral lode of the Little Agnes Claim up Tararu Creek. The belts of country which overlie this are those which are met with in the new diggings; and the first of these is a soft belt, which does not show well on the western side of the range, but crops out above the first rise on the mountain track, and, passing through the mountain as a flat syncline, dips away again to the N.E. at an angle of perhaps 20° on the eastern side, passing through the lower part of the Arizona Claim and into the middle spur. Above this, a belt of hard blue rock occurs, which has not a very great thickness, but may still be seen at several points, notably in the gully between the Young Colonial and New Find Claims. Above this comes the belt of country in which the New Find, Eureka, Golden Crown, and Young Colonial, as well as several other claims, have got or expect to get their gold, and this belt consists of a rather hard, partially-decomposed, felspathic rock, in which a good deal of pyrites is present at times. It is a harder class of country than is generally considered favourable for gold at the Thames and elsewhere, but is, I think, the same rock, in which the filling of the reefs has not been attended by so much decomposition. A belt of hard blue rock (anamesite ?) overlies this and caps the range about Peter Ferguson's Victoria Claim, runs through the mountain at an elevation of about 2,000 feet, and caps the far ranges, dipping away towards the Waitawheta Valley; and on the summit of Te Aroha Mountain it is overlaid again by a softer class of country.

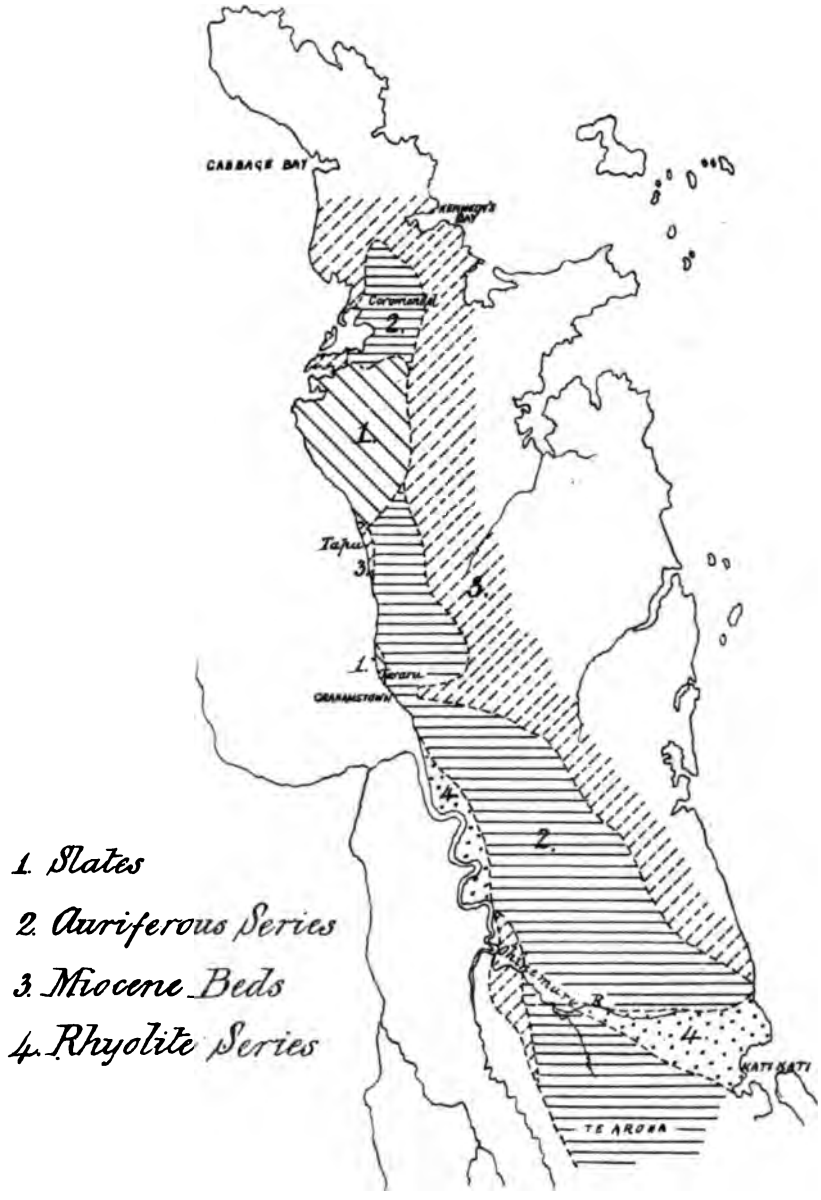


Section through Te Aroha. 1. Soft tufaceous sandstone. 2. Hard belt of dioritic rock. 3. Soft tufaceous sandstone with hard bands (Shotover belt). 4. Belt of hard brown rock (original prospectors' claim). 5. Hard breccias (Hape Creek stone). 6. Soft tufaceous sandstone (lower part of Arizona Claim). 7. Hard green dioritic rock (gully between Young Colonial and New Find). 8. Tufaceous sandstone (New Find and Golden Crown belt). 9. Hard blue rock (anamesite ?). 10. Soft tufaceous sandstone. A. Te Aroha Mountain. B. Main reef. C. Middle spur.

I should mention that, at Coromandel, in addition to those auriferous rocks which are met with in the Tokatea (*see* section, page 8), where is also a patch of rocks at the Tiki, which undoubtedly belong to the formation I am at present describing, and that these beds are lying comparatively flat, and resting unconformably upon

CAPE COLVILLE PENINSULA

TO ILLUSTRATE REPORT BY S HERBERT COX



Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.

A

the slates which crop out in the Matawai Creek. They are identical in character with the auriferous rocks of the Owharoa and Waitekauri Gold Fields.

As the distribution of these beds is of the greatest interest and importance, I attach a small map showing their approximate boundaries, as well as the other formations which are developed on the Cape Colville Peninsula, together with the strike and dip of the beds where I have observed them.

Lower Miocene Beds.—The next series of beds which is met with in ascending order are the Lower Miocene breccia-beds, which are the same as those described in a previous report as occurring at the Manukau Heads (Geological Reports, 1879–80, p. 16). These are developed at various places throughout the Cape Colville Peninsula, but are more or less confined to the eastern side of it, coming down, however, to the western side at Beeson's Island, Coromandel.

Their relations to the auriferous beds last described are somewhat difficult to make out, for where they are in direct contact with them the flat dip of both series renders it a hard matter to decide whether or no an unconformity exists. In the Tapu district I mentioned before these beds come in on Mata Creek, just above Gentle Annie Creek, above which no gold has been found up to the present time. About 1½ miles above Gentle Annie Creek a branch creek comes in from the southern side, and up this coal has been discovered. I visited this locality, and found that the coal obtained there was of the same character as the Mahurangi coal (Geological Reports, 1880–81, p. 24), occurring in small pockets in a sort of shale, which was interstratified with tufaceous clays and trachydolerite breccias, and was distinctly overlying the auriferous rocks, but whether conformably or not I was unable to determine at this point. The thickest bit of coal which I saw there was about 2 inches thick, but there were several feet of strata in vertical section in which these patches of coal could be obtained. I was informed that in the next creek higher up a seam about 5 inches thick had been found, but, as it was doubtless in the same formation, I did not visit this locality. I find, on inquiry, that it is from this last place that the reported seam of coal occurs which I was instructed to report on, and of which samples were forwarded by the Hon. Mr. Whitaker; but I could hear of nothing in the district which corresponded with the 12-feet seam; and, on further inquiry in Auckland, the thickness was allowed to fall from 12 feet to 2 feet by the discoverer, so I should not be disposed to attach a great deal of importance to the discovery. The section which is exhibited is the same as that depicted on page 14, but the unconformity which is shown is not very apparent in this locality, and it is on account of my observations elsewhere that I have shown it.

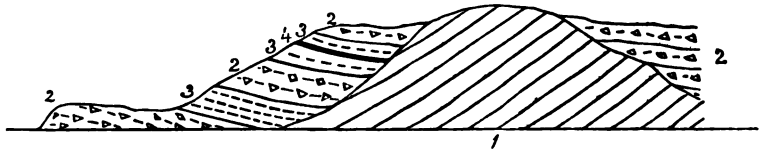
At Coromandel these beds, as breccias, form the whole of

Beeson's Island, skirt the coast on the other side of Coromandel Harbour, and stretch along the northern coast in the direction of Cabbage Bay, and also rise up into the ranges in that direction. They flank up against the auriferous rocks at the Union Beach Mine, a dyke of dolerite occurring at their junction, which is seen at the surface, and was again met with below ground, where it bounded the auriferous formation. I was unable to see this at the time of my visit, as the mine was not at work, and the shaft was filled with water.

In Beeson's Island again these rocks are traversed by at least one dyke of dolerite, and they exactly correspond in character with the breccias of the Manukau Heads. On the Kennedy's Bay side of the Tokatea Range they again occur, and here also overlie the auriferous rocks unconformably, and the formation is traversed by a very large dyke of trachyte-porphyry which forms the whole of Castle Rock, and strikes E.S.E. through the country; it is several hundred feet thick, and a similar rock has been met with in Kikowhakarere Bay, on the line of strike, where it has been mistaken for granite by some people who are interested in working it for a building stone. The section from Kennedy's Bay to Beeson's Island (p. 8) shows the relations of these beds well.

On the range from the Tokatea to Cabbage Bay the auriferous rocks can be traced on the surface until the turn-off to Kikowhakarere Bay is passed, beyond which the rocks do not show well on the surface for some little distance, and then angular pieces of trachyte rock make their appearance. These fragments, I conclude, are derived from the Miocene breccias, as these rocks can be seen cropping out at places along the road, although in a very decomposed state. No very good sections are to be obtained, but beds of tufaceous sandstone, very much decomposed, are seen, and again beds of these breccias also in a highly decomposed state. At one point a belt of rock which would appear to belong to the auriferous series is seen cropping out on the surface, but it occupies only a very limited area, and is speedily covered again by the younger formations, which, however, can be only very thin here. As we descend towards Cabbage Bay these younger beds occupy a much greater area of country, and are of a considerable thickness, occurring right down to the flat. They vary in their dip, but are generally lying at angles of not more than 20°, and are frequently much flatter. The coal occurs in these beds at an altitude of about 800 feet above the level of the sea, with a tufaceous clay on which rests a tufaceous sandstone, overlaid by the breccias in a very decomposed state; and from the coal to the level of the flat the beds consist of alternations of tufaceous sandstone, breccia, and clay. The outcrop of coal is 5 feet thick, but, as shown by the analysis last year, is very impure, and, on a close examination, appears to consist of numerous thin veins of shale which contain a good deal of carbonaceous matter, with which are

seams of a really good coal, but so thin as to be of no practical value. It would correspond with the coal of Mata Creek and Mahurangi in this particular, only the shale has more the appearance of coal here than at the other localities. These younger beds lap round the auriferous series at the northern end, as shown on the plan; and the auriferous beds have been found close to the coal at Cabbage Bay, so that the section from the summit of the range to Cabbage Bay is much as follows:—



Section through Miocene beds, Cabbage Bay. 1. Auriferous series. Miocene: 2. Breccias; 3. Tufaceous sandstone and clay; 4. Impure coal-seam.

Another patch of these beds occurs in the Ohinemuri District, about two miles from Paeroa, on the road to Waitekauri; and coal is reported to have been found up a creek which crosses the track at this point. I went to see this seam with Mr. Hennelly, who has interested himself largely in it; but he was unable to find the outcrop. The measures occupy a hill lying to the westward of the auriferous belt at this place; they are dipping westward at low angles, and two seams are reported as having been found.

Between Mackaytown and Te Aroha a belt of the same country occurs, forming the western spur of the main range, but consisting here of doleritic lava flöes, which have weathered over considerable areas into a boulder clay, with large dolerite masses yet left as undecomposed kernels. In the Thames district these rocks occupy the high country to the eastward of the Alburnia and Nolan's Candlelight Claims, form the Look-out Rocks, and occupy the high country stretching round by Table Mountain. They also descend the spur between the Moanataiari and Waiotahi Creeks, and are again met with up Hape Creek, where they are resting unconformably upon the auriferous rocks. These beds frequently exhibit a marked concretionary structure in their decomposed parts, and in places, as up Karaka Creek, they contain heavy boulders of anamesite, sometimes many feet in diameter, forming a boulder clay very like some of the Otago rocks. The same class of country was driven through on the spur between the Waiotahi and Karaka Creeks; and in the central part it proved to consist of a dark-green tufaceous deposit, which closely resembles the rocks of the North Auckland district; and I am informed that *not a single reef was met with in this drive.*

When we come to examine the country on the surface, no doubt remains that these beds are distinct from the auriferous series, for this reason: We find that the deposits of brown tufaceous rock (due to the surface-weathering of the green rock cut in the drive)

do not follow a definite level, but are sometimes at a very great elevation—1,500 feet or more,—and at other times they are met with on spurs which are comparatively low-lying—not more than 300 feet above the level of the sea. When we seek a cause for this, it is at once apparent that the auriferous rocks had been deposited, upheaved, fractured, and partially denuded—indeed, so much so that the conformation of the country corresponded more or less with that which at present exists—before these younger rocks were deposited upon them. These beds are traversed at places by dykes of basalt, anamesite, and dolerite, through which reefs have never been known to pass, and which do not appear in any way to affect the auriferous characters of the country, being younger than the reefs.

Rhyolitic Formation (Pliocene). — A yet younger volcanic formation occurs in this district, occupying part of the Ohinemuri Valley, and I have casually alluded to this before when speaking of the Smile of Fortune and Radical Claims, at Owharoa. These beds consist of a pumiceous clay, which has been cut through in two of the Radical levels and taken for a slide. It is, however, nothing of the sort, but fills an old gully which had been formed in the auriferous rocks prior to the deposition of these beds. It is met with again on the slopes of the spur at the foot of which the Annie Claim is situated, and, passing through the saddle above Farmerville to the west, is seen again cropping out on the road-line in that direction, making its course about E.–W. On the opposite side of the river to which the Owharoa township is situated the same class of country has been cut in a drive after passing through a narrow belt of auriferous rocks, and here the beds are associated with a belt of porphyry (which is considerably decomposed) at their base, and this has sometimes weathered in the concentric manner I have before described. The pumiceous clays rise to the top of this range, it being through them that the water-race which supplies the battery has been cut, and they extend for some distance in the direction of Waitawheta, as is illustrated by the section (page 15). In following the road from Owharoa to Waihi the clay band which crops out on the Annie spur may be traced for some distance, as shown on the plan, rising up on to the hill, which is passed over before the turn-off to Waitekauri is reached. From this point the road follows undulating ground for a long way, and at places the clay band appears, lying indiscriminately upon the auriferous rocks and the hard belt which I have described at their base, where the auriferous rocks have been denuded. This clay band has to a large extent determined the course of the Ohinemuri River near Owharoa, and also no doubt has been instrumental in forming the falls in Waterfall Creek, which are situated just above the township. At the battery site on the Waihi Plains an outcrop of rhyolitic lava, consisting of a mixture of pumice and obsidian, occurs associated with these

pumiceous clays, and a similar rock occurs on the Waitawheta track very near to the Ohinemuri River. The whole of the Waihi Plains, on the southern side of the Waihi track, may be looked upon as belonging to this the youngest volcanic formation of the district, and one which corresponds with the rhyolitic beds of the interior, near Taupo. It appears probable that the sinters, &c., of Puriri also belong to this formation; but very little is to be seen of these, since they occupy low-lying fern-covered ground, in which sections can only be obtained with great difficulty.

Pleistocene Beds.—The only other formation which remains to be mentioned comprises the Pleistocene deposits of the Thames and tributary rivers, and to these I have paid very little attention. Captain Hutton reports (Geological Reports, 1868–69, p. 22) that "a shaft sunk just behind the town [Shortland], after passing through a marine formation of sand, with broken shells, about 10 feet thick, traversed 68 feet of gravel composed of stones of tufa, dolerite, trachyte, quartz, and occasionally rhyolite and obsidian. It then got into pumice-sand, after penetrating which for 10 feet it was abandoned."

II.—The Characters of the Reefs, with a Description of those Points which appear to have more or less regulated the Distribution of the Gold.

In entering upon a discussion of this extremely interesting branch of the subject, which has formed my study for the principal part of the past season, I wish clearly to disclaim any idea of propounding a theory. I have, in pursuing my investigations, visited most of the important mines at the Thames and many of those which are being worked elsewhere, and, while examining the workings at the different mines, I have obtained far more information from the various managers in the course of conversation than I have from actual observation. This was to have been expected when it is considered that those parts of the reefs which have proved rich have been rapidly worked out, and the workings have since in most cases closed in. I have been guided to a large extent in my inquiries by the laws laid down in M. Moissenet's excellent work on "The Lodes of Cornwall," certain extracts from which I propose to quote before going into a description of this district, considering that it was more than likely that those rules which hold good in one district of metalliferous lodes would, with certain modifications, also apply in another even when the class of metal to be worked was different; and I find that to a large extent I was justified in my supposition, although many special characteristics are observable here which modify his results in some ways.

It is with pleasure I take this opportunity of thanking Mr. J. M. McLaren, the Mining Inspector; Mr. George Wilson, the Underviewer; Mr. Bayldon, and the managers one and all, for the

kindness I have experienced at their hands, and the readiness with which they have imparted information which without their assistance it would have been impossible for me to obtain; and I hope the compilation of their observations, which it is my good fortune to have this opportunity of making, may lead to a greater interest being developed in what on a new field may appear minor matters, but a careful record of which is the only means of arriving at any approximate solution of the difficult problem, "Where is the gold to be found?"

As is natural, the greatest amount of information concerning the behaviour of the reefs is to be obtained at the Thames, where a far greater amount of work has been done than at any other part of the peninsula; and in describing the reefs, &c., I shall treat of each gold-mine separately, devoting a greater quantity of my space to this district, but noting any points of interest elsewhere which I have been able to collect.

The following is a brief mention of those rules of M. Moissenet to which I have already alluded:—

1. *Inclination or Underlie.*—"In a lode we have to consider not only the *mean* inclination, but still more the *successive* inclinations of its cross-sections. *Those parts whose inclinations approach most nearly to the vertical are always the most productive.*"

2. *Moderate Hardness.—In Cornwall the rich parts are generally enclosed in rocks of moderate hardness.*

This rule he points out must not be extended without reserve to all mining countries, but, from a mechanical point of view, argues that "a favourable rock is one easy to break, but hard enough to remain open without timbering." It will therefore be apparent that the test of hardness of the country can only be a comparative one in a district known to carry metalliferous lodes, and so that a class of country favourable in one locality may be unfavourable in another owing to a more favourable one being present.

3. *Dip* (of the courses or shoots of ore).—*The metalliferous bands or zones often dip in the same direction as the enclosing rocks.*

4. *Proper Bearing.*—The bearing of the rich parts is generally that of the stratigraphic system with which the initial fracture of the lode in the region under observation is connected.

In summarizing these results he says, "Thus, whatever the direction of dip may be, we see that strata of good quality are generally fractured more nearly to the vertical, and more in accordance with the bearing of the system of fracture, than the bad ones; and *good strata* are those which contain the normal riches. The four general characters, therefore, are clearly the result of one phenomenon, viz., the fracture of strata of different qualities by forces acting along a straight line parallel to a given system; and *these characters determine the conditions of the normal rich parts of the deposits.*"

I may state that, while I believe these rules apply largely to the normal rich parts of the auriferous deposits of the Thames, there are also accessory riches in which they are not generally applicable, or in which only one or more of the rules would apply. I propose to give in detail the observations which I have been able to collect from the different mines; but must ask that, in reading them, the foregoing rules may be borne in mind.

The strike of the country here is approximately N.N.E., and the dip W.N.W. at an angle of about 1 in 2; while the main strike of the auriferous reefs is N.E., with a N.W. underlie at a steeper angle, thus causing the reefs to pass through the different belts of strata.

THAMES DISTRICT.

Kuranui Hill Mine.—The main strike of the reefs in this mine is N.E., and they vary in thickness from ½ inch to 3 or 4 feet, or even more at a few exceptional places. The gold in these reefs has generally run in shoots, of which the greatest vertical depth has been about 120 feet, this shoot having been obtained in the Long Drive leader, about 120 feet from the mouth of the tunnel. The underlie of these reefs and leaders is always N.W., and in most cases they stand at high angles for their average dip, but vary in different parts of the reefs. In horizontal extension they appear to run 30, 40, or 60 feet with payable stone, which is followed by inferior metals. In the lodes of this mine the character of the country through which they are passing appears largely to affect the distribution of the gold, while the nature of the mineral contents does not seem to exert so much influence on its distribution as the hardness or kindly character of the ground. As a matter of fact, the white fairly-hard stone is the best country; and where more mineralized belts come in the reefs are frequently pinched or split up, and in one instance that I saw, the flattening of the reef in unkindly strata had resulted in the entire absence of gold for the time. The greatest desideratum here appears to be that the reefs should be traversing country possessing a moderate degree of hardness, sufficient to insure that the fissures formed would remain open. This character is imperative, and, when it is insured, then droppers into the reef carrying mineral are frequently of importance. As regards the influence exerted by changes of underlie, I had no opportunity of judging the results in this mine.

The gold has chiefly been obtained from those levels which are above the Long Drive: indeed, nothing to speak of has ever been found below that, although the Duke's leader in this mine is supposed to be the same that gave the Moanataiari rich patch at 80 feet below the level of the Long Drive. The reefs have not died out below the Long Drive level, nor does the character of the country appear to have changed much, but still there is a change

in parts, which is readily recognized by the practised eyes of the managers. In the All Nations No. 3 reef, in the same mine, but on the north-west side of the tunnel, the gold occurs under different circumstances. The reef is about 2 feet thick on an average, but with big blows, some of which were very rich. From one of these blows 800 oz. of gold were taken from one patch on the run of the lode, and both above and below this no gold was found in payable quantities. Several of these patches were found on the horizontal extension of the lode, and a great deal of gold extracted. The patches have no great extension any way in themselves, but they follow a more or less horizontal line, and as far as proved have not repeated themselves in depth. As a rule, where the rich patches have come in the lode has swelled, but few or no stringers have appeared in either wall. This is an exceptional lode, being the most patchy one in the mine, but at the same time very rich. It has the same general strike and underlie as the rest of the lodes.

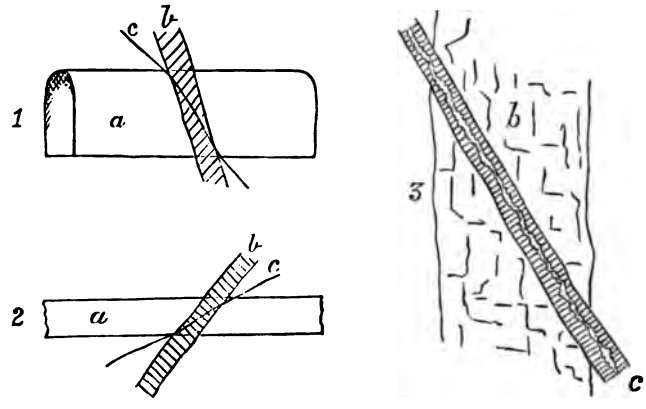
In the old Albion area a cross course has been met with, and is known as Kelly's cross lode. This lode runs about N. 10° E. on an average, and underlies to the westward, but deviates considerably from its course, veering to the east and west from time to time, and is also crossed by slides. It has been worked from the surface to the Long Drive level, where it is standing at high angles, and has been payable throughout, being very rich at places. A shoot of gold occurred between the surface and the surface level, a distance of 100 feet. The deviations in their course do not appear to have affected the thin leaders much, but Mr. Crawford, the manager, informs me that the large reefs generally carry better gold when they turn to the eastward, and that at these points the reefs widen out. He also states that the small reefs less frequently carry shoots of gold than the larger ones, but in these small reefs the gold occurs more in horizontal extension.

In that part of the mine which is worked from the Caledonian shaft is a thin leader worked in a hard white tufaceous country at the 200-feet level. This leader strikes about E. 10° N., but where it is at present being mined the country is not considered good by the manager, and the vein is not paying. I am bound to say that at this point I was unable to distinguish between the good and bad classes of country, unless it be by the absence of the small black veins, and from hand-specimens no one could tell the difference. In this mine the course of the reefs appears to vary from N. 10° E. to N. 80° E.

Moanataiari Mine.—The gold workings in this mine have been extended both to the north-west and south-east of the main tunnel, and have been carried on in a number of different reefs and leaders. On the north-west side of the tunnel the greater number of the workings, and those which have proved the richest hitherto, have

been at and above the tunnel level, the gold occurring in patches in horizontal extension much as I have described it in the No. 3 reef of the Kuranui Hill Mine. At the 70-feet level (below tunnel) a little gold is still being got in leaders where the country is favourable. On the south-east side of the tunnel a long cross-cut has been put in, which has cut through the main slide, then turned back to make for the Nonpareil shaft; and in some upper workings driving is now being carried on to connect with the Central Italy shaft, although at present through barren country. Nothing to speak of has been got in this direction in the cross-cuts, and the most important work is that of the 80-feet level, where the last rich patch of the Moanataiari Mine was obtained on a north-east lode, where it was standing at a pretty high angle.

A very interesting section is seen here, close to the No. 9 rich patch. At this place, what is known as a "buck reef" occurs; this term being applied to a series of non-auriferous reefs which follow a more northerly course than the auriferous ones, and trend more to the west than east: they are also called "flinties," but this term is hardly an applicable one for general use, since it would imply that all these reefs are of a flinty or cherty character, which is not always the case, although it frequently is so. This "buck reef" is intersected by a thin auriferous leader, which can be seen passing right through it at an angle, the walls being clearly defined throughout its course. I could not detect any movement having taken place along the line of fracture.



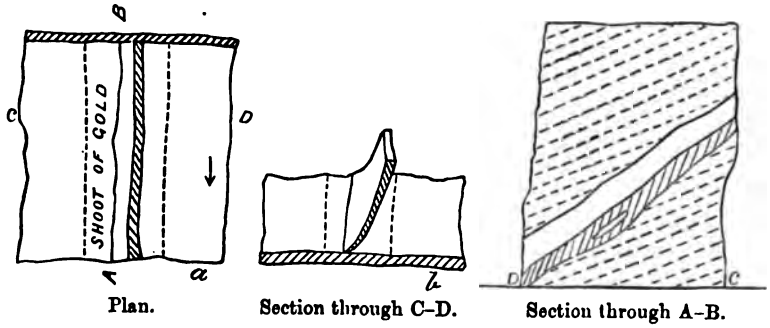
Sections of leader in Moanataiari Mine. 1. Section. 2. Plan. 3. Enlarged section. *a*. Drive. *b*. Buck reef. *c*. Auriferous leader.

This intersection is of great interest, as showing that the "buck reefs," which follow a more north-and-west course, and do not carry payable gold, are of greater antiquity than the auriferous leads of the district.

Another very interesting point is also illustrated here in what is called the No. 9 branch leader. This leader is striking N.E.–S.W., and dipping N.W., and has carried good gold. At the point to which I refer the reef takes a sharp turn, thus:—

the gold being cut out by the turn, but making again when the reef resumes its course. The turn dips in a S.W. direction.

Golden Crown Mine.—This is one of the most interesting mines in the field, and the No. 1 reef is specially instructive in its characters: this reef, which does not generally dip at a very high angle, has a N.E. course and N.W. underlie. It was, throughout a belt of good country which crosses it, a payable reef, but in what is called the "shot of gold," a band not more than 60 feet in width and at places considerably less, the richest patch of gold yet got on the field was obtained. This shot followed a regular course through the Manukau ground and the Golden Crown until it met with a clay head which, crossing it in a N.–S. direction, with an easterly underlie, threw the gold in the reef along this course, and took it out of the Golden Crown into the Caledonian Claim, where it widened out into a large patch. At the time this shot of gold was being worked a small leader was noticed coming into the hanging-wall of the reef on the course of the shoot, but, as it was only poor close to the reef, no attention was paid to it: subsequently this leader was opened up, and the vein was found to get more vertical shortly above the junction, and very rich gold indeed was obtained.



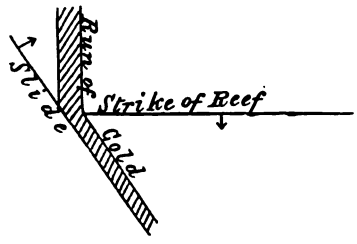
Plan. Section through C–D. Section through A–B.

Plan and sections of junction of hanging-wall leader with No. 1 Reef, Golden Crown Mine.

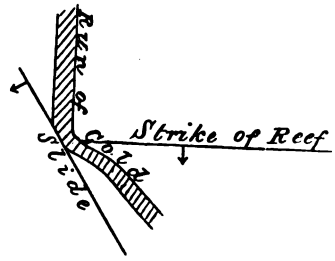
Both in the main reefs and also in the leaders the steeper parts proved the richest, and where any change took place the gold, though frequently coming in with the hanging-wall, generally

went to the foot-wall at once, and whether enlarged or not the more vertical parts of the reef appear to have been the richest.

Where slides have been met with they appear to have affected the distribution of the gold in the manner illustrated by the following sketches:—



Plan I.

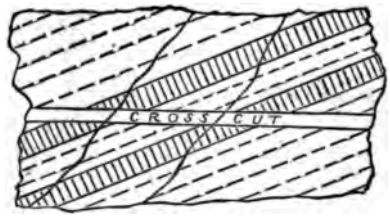


Plan II.

That is to say, if a shoot of gold is intersected by a slide which is dipping towards the dip of the reef, as in Plan I., the shoot of gold will follow the hanging-wall of the slide on the dip of the reef; but if it is intersected by a slide which dips away from the dip of the reef, the shoot of gold will be thrown away from the slide into the reef. In other words, reefs which intersect the hanging-wall of a slide carry their shoots of gold with the slide, whereas those which meet the foot-wall have their shoots of gold thrown by it. Certain dry watercourses traverse the rock at places in this mine, and these invariably cut off the gold, but I am informed by Mr. Dunlop that they are never seen in the best classes of country unless it be close to the junction of another class of rock.

Cure Mine.—It was in this mine, which is one of those worked from the Caledonian shaft, that I first obtained any insight into the bedding of the strata in which the auriferous reefs occur. It adjoins part of the Golden Crown Claim, and has, since I was there, passed into the hands of this company. I was unable to discover in this mine that the course of the reefs or the angle of their underlie had affected their gold-bearing properties in any way; but the different belts of country are most marked in their bearing upon the auriferous reefs. When these are passing through a good class of ground, such as I have previously described, they are remunerative; when they get into very hard or jointy ground they do not pay to work. Mr. Clark, the manager, showed me everything he could in connection with these reefs, and pointed out that, whereas the reefs themselves were underlying at an angle of 45° or over, the belts of country were lying much flatter, so that where he had driven along a reef through good country, and had come into jointy ground, he was always certain that he had only either to rise, or sink a winze, as the case

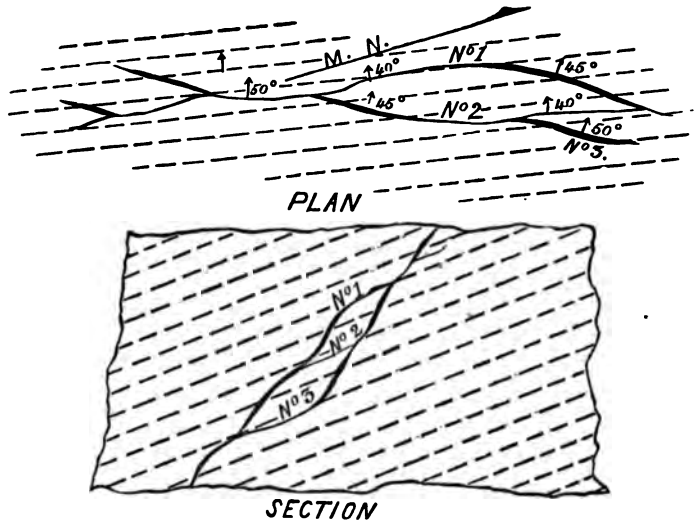
might be, to get once more into the better class of rock. He showed me one or two instances where he had done this and been successful; and, when I was there, he was putting up a rise in poor country with the same object in view. The following section illustrates this:—



Vertical section through reefs and strata in Cure Mine.

This at once threw a light on the stratification of the rock; and, following up the clue thus obtained, I have been able to trace the influence of the bedding elsewhere upon the reefs. It was not, however, until I visited the Waiotahi Mine that I had an opportunity of at all accurately fixing what were the strike and dip of these beds.

Caledonian Mine.—The general strike of the reefs in this mine is about N.N.E., and payable gold has been obtained as low as the 350-feet level, below which the reefs have not proved remunerative. There are three reefs in this mine which frequently come together and then separate again, following a snake-like course through the country; and, according to Mr. Hicks's view, No. 2 or the central one appears to be the main reef of the mine. It has been observed that where these reefs coalesce no gold to speak of has been got from them; but where they part gold is obtained in one or the other according to their course. When these reefs separate, they generally flatten in their underlie, and, while No. 1, going northward, is generally poor, No. 2, taking a more easterly course, as a rule makes good gold, this being true whether No. 3 also separates or whether Nos. 2 and 3 remain as one. When No. 1 turns to the eastward and No. 2 towards the north to junction, No. 1 makes the gold; and the same remarks apply to No. 3 reef when it separates from No. 2. It will be evident from this that the more richly auriferous parts of the reef have generally a N.E. strike, and also that where these separate it is the steeper reef which carries the gold; and, further, that where each auriferous reef flattens it becomes poorer. The following plan and section illustrate the behaviour of these reefs, the thick lines representing those parts which have been auriferous, and the thin lines the poor parts:—

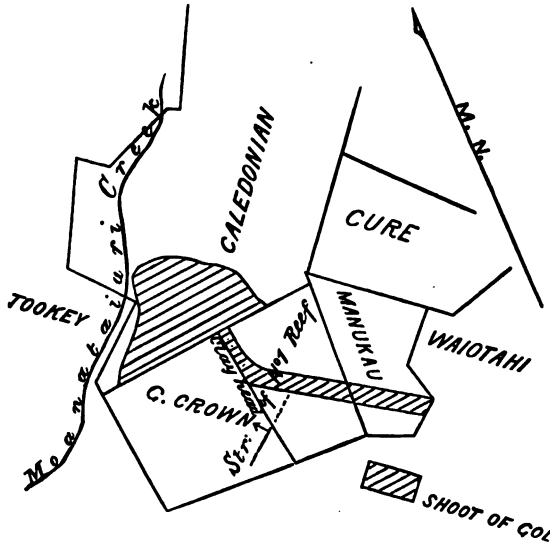


The famous specimen leader of the Caledonian Mine left the foot-wall of No. 1 reef, and after forming a half-moon rejoined it again, being rich throughout, its course making no difference in its value. Between the No. 1 reef and the specimen leader several other leaders occurred, interlacing in every direction, and they all carried good gold. The No. 2 reef appears to be the lode of the country, and the others join and diverge irregularly. Where the reefs junction, the lode generally swells to a great thickness, sometimes as much as 30 feet; but in No. 2 level, where the whole three junction at one point, they are pinched to less than 2 feet in thickness.

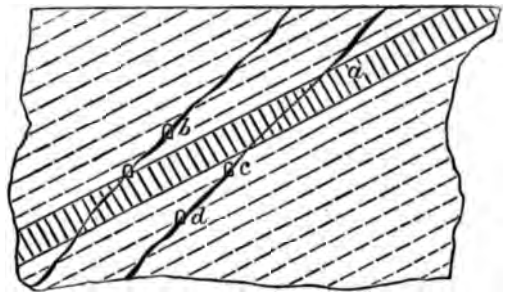
The shoot of gold which was so remunerative in the Manukau and Golden Crown Claims was thrown into the Caledonian area by a clay head to which I have already alluded, and in this mine it has flattened and spread out laterally, rendering the mine an exceptionally rich one. The following sketch, which shows the boundaries of the gold in the three claims, will illustrate its mode of occurrence, but I have been unable to arrive at any solution of the causes of its spreading in the Caledonian Claim. It is possible that poorer ground is delineated on the outside of the Caledonian area than was mapped in the Golden Crown, for the reef was payable throughout.

The same remarks that I have made when speaking of other mines concerning the different classes of country also apply here, and it is only in the compact, moderately-hard rock that rich deposits of gold have been obtained. At the 350-feet level one of those belts of hard rock, similar to that met with in the Moanataiari long tunnel, was struck, and a very curious circumstance has been noted in connection with this. As stated, it was met

with in a drive at the 350-feet level, and cross-cuts have since been put in above, below, and on each side of this rock without meet-



ing it, so that it would appear to be an isolated patch. This, however, I am convinced, from evidence I have gained elsewhere, is not the case, for the dip of the country would carry it through this level without it being met with in these drives or cross-cuts, the following sketch illustrating its mode of occurrence:—



a. Hard belt of country. *b*. 270-feet level. *c*. 350-feet level. *d*. 450-feet level.

This belt of rock would appear to be the same as that met with at the bottom of the Golden Crown shaft, as illustrated by the section (page 26).

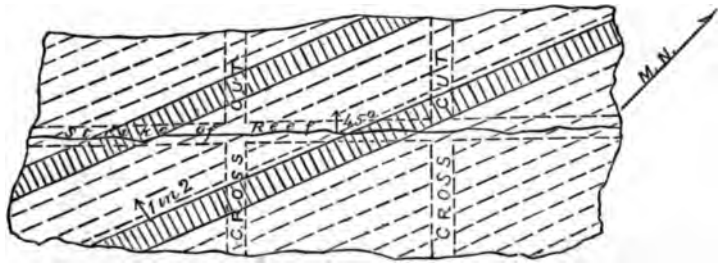
Waiotahi Mine.—In the Waiotahi Mine the reefs have generally a N.E.–S.W. strike, with a N.W. underlie, and the main reef, known as No. 5, has been continuous from the upper level to the present one, about 300 feet below the surface. The other reefs which have been worked are chiefly foot-wall leaders or droppers which traverse the country more vertically than the main reef, and these are the ones which have proved the most remunerative.

There are many points of interest in connection with this mine which the observant manager, Mr. Smith, has been at some trouble to point out to me. First of all, Mr. Smith is working numerous small veins which range from $\frac{1}{16}$ inch to $\frac{1}{2}$ inch in thickness, and these are at times exceedingly rich. They are chiefly foot-wall leaders from other reefs, the whole forming a network of veins which are in one way or other attached to the No. 5 reef previously mentioned. These veins are subjected to numerous movements, caused chiefly by the intersection of small clay heads or slides which are met with at places every 5 or 6 feet. Along these slides, and close to them, gold is very frequently obtained.

The class of rock in which these leaders occur is also very potent in governing the yield of gold. A fairly-hard compact rock is the one in which the greatest quantity of gold is found, and where the black veins I have so frequently alluded to are most plentiful the richest gold occurs. There is a notable point, however, in the working of this mine which we have no account of elsewhere, and that is that in many cases, indeed almost always, Mr. Smith crushes these small black veins themselves and finds that they are remunerative. This has never been done on any other part of the field so far as I can judge, although all notice that where they join the leaders the richest patches of country are met with.

I should mention that lately the Golden Crown was crushing part of a spur which is a mass of leaders, on a face, while they were unable to work the lower levels of their mine, and that this was yielding a fair return.

I got more information about the stratification of the rocks in this mine than in any other. A belt of jointy rock has been traced from the upper to the lower levels, but has been cut through in every direction in the drives which have been entered, and this belt has dipped to the N.W. at an angle of 1 in 2, but has also a westerly dip, making the true dip about W.N.W. at a slightly steeper angle than that mentioned. This, it will be seen at once, explains the bars of country which appear to occur in such an irregular manner in the mines, and which are driven through both in the levels and cross-cuts, which are always either along or at right angles to the reefs, these striking N.E., and thus intersecting the bedding of the country at an acute angle. The following sketch will illustrate their mode of occurrence:—



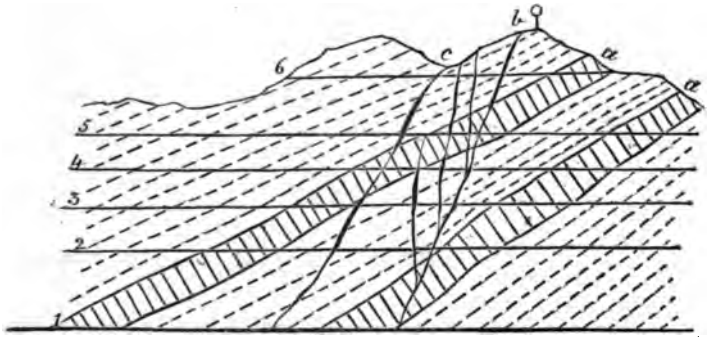
The very imperfect stratification which prevails in this district makes it very difficult to observe this dip, and it is only by obtaining information below ground that any idea of the place can be formed. This arrangement of the belts of country works out the whole system of the field in a most remarkable manner, but the richness of the auriferous deposits depends upon many other causes which relate to the physical characters of the reefs themselves, and to which I have already more or less referred.

Queen of Beauty Mine.—This is the last mine to the seaward side of the fault to which I need refer. It is of great interest, as being the deepest mine in the district in which gold has been got at the lower levels. When I was at the Thames the water had only just been got under, and very little work was being done in the mine, so that there was practically very little to see: it is, however, proposed to continue the workings of the old Piako Mine, which fell in some time ago. The class of country in this mine has been pretty uniform from top to bottom, consisting of the white tufaceous sandstone, which is considered to be good or kindly country. The reef, too, which was worked from the surface to the 540-feet level, stood nearly vertical, and in changing its underlie passed from a N.W. to a S.E. dip, so that it was met with three or four times in sinking the shaft. At the bottom of the shaft the breccias of Karaka Creek are met with in a decomposed state, which would not be an unkindly class of ground, and resembles that in which the Hape Creek Claim is working; so there is no reason to suppose the gold will be cut out at once below this level. I was unable to gain any information concerning the behaviour of the reefs in this mine, owing to work having only just been resumed.

It is not very clear what course the slide follows to the eastward of where I have delineated it on the plan, as it is difficult to trace this on the surface, but I am inclined to think that it passes to the northward of Una Hill, which would place the claims situated there on the seaward side of it. In Karaka Creek a belt of very hard breccia, which has been solidified, and cemented by carbonate of lime, strikes up and down the creek, and at places passes into a crystalline rock which is very hard, but so conforms with the breccia in strike and dip and passes into it so imperceptibly that one cannot for a moment consider it to be a dyke. These hard belts of country are not looked upon as kindly—indeed, I should not expect them to be,—but in the same class of rock, towards the mouth of the creek, where it is not so hard, some very good gold has been got; and even where the rock is hard, thin belts of better country are at times interstratified with them, and then reefs make and have been found payable.

Alburnia Mine.—The Alburnia Mine is worked by a series of cross-cuts which are put in from the gully cut by the Moanataiari Creek, and these pass through a hard belt of country before

reaching the auriferous belt, another hard belt lying beyond this. The lowest drive which has been put in is the Sons of Freedom level, in which no gold to speak of has been obtained: it bears N. 5° W., thus nearly corresponding with the strike of the country, which it crossed at a very acute angle. The Sons of Freedom reef has been intersected by this drive in the hard rock—which has, however, been fractured—for a distance from the line of reef sufficiently wide to allow of a drive being entered at a moderate cost; but this does not appear to have improved the yield of gold in any way, for the reef is absolutely barren. Taking the dip of these beds to be W.N.W. at an angle of 1 in 2, which is approximately correct, we should expect that as we rise on the reefs this belt of hard country would not be found on the hanging-wall side of the reefs, but would be intersected by cross-cuts from the foot-wall; and this is practically what we find to be the case. In the next level, which gives 158 feet of backs between it and the Sons of Freedom level, and is known as the 160-feet level, no hard rock has been met with on the hanging-wall side as far as the drives have been extended, the reefs which have been worked all occurring in a belt of kindly country, as shown in the accompanying sketch:—

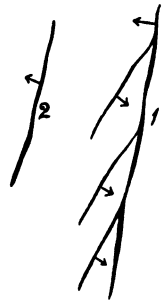


Section through Alburnia Mine, showing the position of hard belts of country. 1. Sons of Freedom level. 2. 160-feet level. 3. 70-feet level. 4. Whau level. 5. Battery level. 6. Success level. *a*, *a*. Hard belts of country. *b*. Sons of Freedom reef. *c*. Dixon's reef.

On the foot-wall side of the reef the country has not been proved, as reefs were not expected in that direction. In the next, the 70-feet level, which is 90 feet above the 160-feet level, and 70 feet below the Whau level, hard rock was cut below the cross-cut in the Whau on the hanging-wall side of the reefs; and in the Whau level no hard rock was seen between the Star of the South and Sons of Freedom reefs, but between the Sons of Freedom and Dixon's reefs and beyond Dixon's it was met with. This is evidently an upper or overlying belt, since the hard rock is not met with in the cross-cuts on the foot-wall side, as far as they have driven. In the Battery level, which is 70 feet above the Whau,

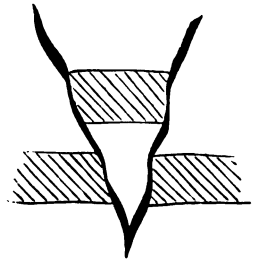
the cross-cuts passed through hard rock both between the Star of the South and Sons of Freedom, and also between the Sons of Freedom and Dixon's reefs, being thus principally situated in the upper belt, which is shattered along the lines of reef, as in the Sons of Freedom level. The Success level, which is 120 feet above the Battery level, and about 120 feet on the underlie below the trig. station, 1,140 feet above sea, on the New North Devon Lease, is chiefly in soft kindly country; but hard rock, I am informed, was met with, although I was unable to get the locality accurately fixed, and did not go through that part of the workings. It was probably met with on the foot-wall side of the reefs, as shown in the section.

The reefs in this mine are very steep, the Sons of Freedom and Dixon's being the main reefs which underlie to the N.W., while the other reefs have a slightly more easterly strike and underlie to the S.E., thus forming a junction with the Sons of Freedom reef on the hanging-wall side along a diagonal line, as shown in the accompanying plan :—



Sketch-plan of reefs in Alburnia Mine. 1. Sons of Freedom reef. 2. Dixon's reef.

The vertical parts of these reefs are generally poorer—an exceptional circumstance on this field, and probably due to the fact that the junction of the reefs would take place where the dip is greater; or, to take a more extended view of the case, the reefs were probably opened by the slipping of beds on each side of a keyed block, thus :—



or on the foot-wall and not the hanging-wall side, which would cause the flatter portions to open the more. In other respects the same characters which prevail elsewhere seem equally applicable to the rich parts of these reefs. The class of country exercises the same effect upon their productive characters, and the moderately-hard country traversed by small veins and of a pyritous nature near the reefs is the most kindly for gold.

Nolan's Candlelight Claim.—At a yet higher point than the Alburnia gold has been obtained at Nolan's Candlelight, 1,500 feet above sea-level; and it has also been got in the Lucky Hit Claim, in the gully beyond. The reef in Nolan's was flat-lying, but with a S.E. underlie, or opposite to that of the general reefs.

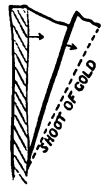
Luck's All Claim.—In the Luck's All Claim what is considered a good belt of country occurs between two hard bands of rock, and this was only wide enough for a drive to be entered. It is needless to point out that this so-called good belt is nothing more than the hard rock shattered in the manner mentioned in the Alburnia Mine, the workings being situated in the lower hard belt of that mine, as shown on the general plan.

Karaka Creek.—In Karaka Creek there are several men, who are known as fossickers, working on junctions of the so-called "bucks" or "flinties" with the N.E. auriferous leaders, and they get a good deal of gold: the N.W. or "buck" leaders are intersected by the N.E. veins, and are occasionally displaced by them. I was presented with some most interesting and instructive specimens from these intersections, showing the gold making at the junction of the two reefs, but always, in these specimens, in the N.E. leaders. As a general rule the N.W. reefs are not very large, but the Onehunga reef is several feet in width; it has not been rich in itself, but where it junctions with the N.E. leaders both reefs are generally auriferous.

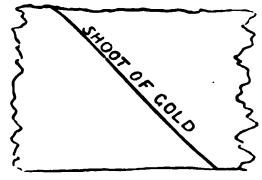
OWHAROA DISTRICT.

In this district the strike of the reefs is rather more northerly than at the Thames, but they still run a few points to the east of north. The No. 2 reef in the Smile of Fortune, which is the most important one yet discovered here, strikes about N. 10° E., with an easterly underlie at an average angle of about 60°; but in the lower level this is flatter. The reef is composed of a mullocky band, at times 12 to 15 feet through, and in most places the walls are by no means well defined. This mullocky reef is traversed in all directions by thin stringers of quartz. It has been stoped out in large belts in the Smile of Fortune ground, and the whole of it is crushed, although some parts are a good deal richer than others. Very little has been noticed concerning the distribution of the gold, beyond this: that the shoots of gold run diagonally across the reef to the dip, and follow lines of junction with leaders, which, while dipping in the same direction

as the main reef, are steeper and strike slightly more to the eastward, and so make diagonal junctions as I have mentioned. The following plan and section illustrate the way in which these occur:—

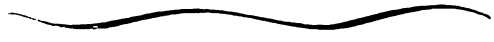


Plan.



Section.

It is in these leaders that the Radical Mine is working, in which some good gold has been got. I have been unable to obtain much information here about the behaviour of the reefs where the richer patches occurred, as the miners do not appear to have paid particular attention to these points. The only rule which appears to have been noticed, outside the influence the class of country has on the reefs to which I have so frequently alluded, is that where "flinties" or hard cherty bands of quartz cross the leaders rich gold is found at the junction. These "flinties" traverse the country in all directions, and appear to take the place of the black veins in the ground of the Thames field. The leaders frequently vary a good deal in their strike, and follow a sinuous course—



in short warps or turns, and they are in many cases so nearly vertical that when they change their underlie it is frequently from east to west. After careful inquiry concerning these changes I am unable to say whether they have exerted any influence on the auriferous character of the reefs or not, but would commend the question to the careful consideration of miners.

WAITEKAURI DISTRICT.

The strike of the main reef in this district, which is at places about 35 feet through, is a few degrees east of north, but very little of this can now be seen. At present the Waitekauri Company is working a parallel reef, which was cut in a cross-cut in the No. 2 level on the western side of the main reef. Besides these, there are a number of N.E. leaders, which come into junction with the main reef, and some of these have proved very rich; and where they junction with the main reef it also has carried good gold. The slides also have affected the reefs here much the same as at the Thames.

The gold is generally very fine at Waitekauri: indeed, many specimens in which gold is not visible will wash out to show a remarkably good prospect, and some of the same stone when crushed has yielded as much as 10 oz. of gold per ton.

The only rules which can be gathered at this place are that the gold is dependent upon the class of country, and that junctions of reefs are the richest.

WAIHI DISTRICT.

At Waihi there are two if not three large reefs, which have a N.E. strike and an easterly underlie, besides a number of leaders which are a few degrees more easterly, and probably junction with the large reefs. Up to the present time no rich finds have been made, but a great deal of quartz has yielded prospects of from ½ oz. to 1 oz. of gold to the ton. Up to the present time the field has by no means been proved, but as two batteries are in course of erection we may hope for an early return.

The class of quartz which has been found in the Dulcibel Claim is very curious: it appears to form pseudomorphous crystals after some other mineral which I have not yet had time to determine. It is a big reef, and can be worked easily without shooting. The field is one in which a low return ought to pay well, owing to the easy working and the good water-power.

In a new district like this it is premature to express any opinion concerning the behaviour of the reefs, but I have no doubt that if the peculiarities of the Thames field be remembered, and careful observations made of the behaviour of the reefs as the work progresses, a very important guide will be arrived at for the extension of the workings.

TE AROHA DISTRICT.

The main or New Find reef strikes about N. 7° W., and may be traced from the spur on the western side of the mouth of the Wairongomai Creek to nearly the top of the ridge which forms the watershed of the Wairongomai and Mangakino Rivers. It consists, as far as can be seen, of a hard white quartz which is traversed in various directions by veins of a white vughy quartz, which are all lying flat in the reef. It stands nearly vertical, but appears, if anything, to underlie slightly to the eastward. It rises as sheer cliffs, often 100 feet or more in height, from the spurs which it crosses, and is almost entirely denuded of the enclosing rock; at places it is as much as 20 feet in width or even more.

A large number of claims have been taken up along this line of reef, and also on certain branch reefs which generally follow a north-easterly course, and would junction with the main reef either on the hanging- or foot-wall side. Of the numerous claims (over fifty), few have as yet done any work, but in these the prospects obtained are of a sufficiently encouraging nature to warrant some expenditure in thoroughly testing the field. In every case hitherto, where gold has been proved in the stone, the claims are situated either on one of the N.E. leads or on the main reef at the junction of one of these.

New Find Claim.—This, which is the prospectors' claim, is on

the main reef, where a leader about 8 inches wide, known as the Arizona lead, junctions with the eastern or hanging wall of the main reef. This leader follows a N.E. course until within a few feet of the main reef, where it appears to turn more in a N.–S. direction and to merge into the main reef. Good specimens may be obtained both from this leader and also from the main reef for a distance of 8 feet into the solid near the junction. The gold occurs in small black or blue veins which traverse the quartz in an irregular manner, and these veins do not appear to be continuous, but come in and die out in a very short distance, from a quarter of an inch to a foot or more. Gold is freely visible along the reef at this point for a distance of 60 or 80 feet.

Diamond Gully Claim.—A few specimens have been obtained from a leader which runs nearly parallel with the New Find reef, but when I was on the field no gold could be seen in the reef.

The Coquette, Eureka, and Victoria Claims are situated on a N.E. reef, which is about 4 feet thick, on the western side of the main reef. Of these, the Eureka is the only claim which has yet obtained any notable show of gold. It is about 10 or 12 chains away from the main reef, and the gold occurs in it in a similar manner to that found in the main reef, viz., in small black veins. A praiseworthy energy is being displayed in opening and proving this claim, and the gold, which is very fine on the surface, appears to get rather coarser in the winze which has been sunk.

Young Colonial.—This is a claim on the main reef where a junction occurs, on the hanging-wall side, with a large N.E. reef; and a very good show has been obtained in a drive which passes through the branch leader and into the main reef. The circumstances under which the gold occurs are similar to those previously mentioned.

Queen of Beauty Claim.—This is situated on one of these N.E. reefs on the western side of the main reef, and at a distance of over 10 chains from it; they are getting gold (encouraging prospects) in a lode about 4 feet thick.

Golden Crown Claim.—This claim is working on a reef which has a more easterly course, and good gold is being obtained at a distance of about 3 chains from the main reef. As this lode is on the line of strike of the Queen of Beauty reef, between that claim and the main reef, it is quite likely that it may be the same, but have taken on a more easterly course for a short distance. Up to the present time the work done has not been sufficient to prove whether this is the case or no, and I can offer no opinion concerning it. There is a very good show of gold in this claim, and under the same conditions as the others.

Gold has been found in boulders in the creeks in various other parts of the field, but up to the present nothing of importance has been made public.

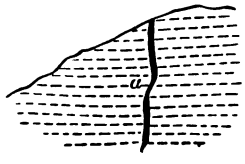
Arizona Claim.—The Arizona leader, which junctions with the

main reef in the New Find ground, has not yet been traced into the Arizona area, although it is not more than about 8 feet from their boundary. The claim is situated on the side of a steep gully, and below the outcrop of the main reef a heavy slope deposit occurs for 100 feet or more down, through which drives have been put in without hitherto striking the solid rock, so that very little is known of the claim. At lower levels the solid rock occurs, but the leader has not been struck in what drives have been entered, and the expenditure necessary to prove the mine at this level is more than the shareholders appear inclined to incur until the field has been further proved, since they would be going some distance from where the gold is known to exist. Since my visit an arrangement has been come to with the New Find Company to allow the Arizona shareholders to sink on the leader in the New Find ground, and then to follow it into their own. Some very rich specimens were obtained from this winze, but I have not heard whether they have been successful in tracing the leader into the Arizona area.

As regards the future prospects of the field, they are, I think, of a very encouraging nature. Gold has been found freely at points more than half a mile apart, and the amount of work which has been done is very small. Moreover, the character of the country is such that no accumulation of gold would occur, and thus the show which is visible is just what was originally deposited in the reefs. Although the gold is very fine as a rule, there would seem to be quite sufficient in sight to warrant the erection of a battery for more thoroughly testing the field, and this has now, I understand, been undertaken. No difficulty will be experienced in obtaining a good site for this, nor in conveying the quartz to the mill, although a somewhat heavy expenditure will no doubt be incurred in the formation of permanent works.

WAIOMIO DISTRICT.

Mr. Workman has spent some time in prospecting this district for auriferous lodes, but up to the present time his work has not been attended with any very successful results. The scene of his operations is situated on the hill to the north of the Waiomo Creek, about a mile from its mouth, and several drives and trenches have been cut in ascending the spur. At present the work being carried on is the sinking of a winze on a reef which is striking N. 20° E., and underlying to the N.W. at high angles. The reef, as I have said, underlies at high angles, but these vary as the winze is sunk, flattening out and pinching about half-way down, thus :—



and then becoming steeper again. It is at the point marked *a* in the above sketch that the best gold has been obtained, but even there no sufficient prospect was got to warrant much expenditure.

About half a mile further up the creek another reef occurs striking E.N.E., and underlying to the northward, and in this copper-pyrites, galena, bornite, and zinc-blende occur as patches. Very little has been done to prove this reef.

TAPU DISTRICT.

Nothing can now be seen in the Tapu District which bears on the behaviour of the reefs, as all the larger workings have been abandoned, and only a few parties of working miners are engaged on the field. There is, however, one point of the greatest importance which should be mentioned here, and that is the fact that the reefs have undoubtedly been traced into the slates which form the basement rock of the district. In the Great Republic Claim, which appears to have been the most extensive mine at Tapu, the reefs were traced down from the tufaceous sandstone country in which they were originally worked into the slates, and, moreover, carried gold in them, but the reefs were pinched, and the country so hard that the workings were very soon abandoned. I have alluded to the distribution of the beds when treating of the geological features of the country.

COROMANDEL DISTRICT.

Tokatea Mine.—The work in this mine is at present being carried on in a low-level tunnel 850 feet below the crest of the ridge. This tunnel, which is entered on the eastern side of the range, has now been driven a distance of 2,050 feet, and is still 1,600 feet from the divide. The formation from the mouth of the drive to the face changes very little in character as far as the class of rock itself is concerned, although there are several changes in its physical characters from time to time. The beds are striking N. 15° W., and dipping to the westward at an angle of 50°; and at 1,700 feet from the mouth of the drive a hard belt of felsite occurs which was also met with in the Van level, 187 feet above this, at a distance of 1,600 feet: this belt is about 100 feet thick in the lower level, and 62 feet in the Van level. In this hard belt the reef was pinched entirely out, but the walls continued well defined, while on the eastern side of it the reef occurred in a broken, jointy class of rock, but was flattened and carried no gold. After passing through the felsite band and reaching the western side we find that, although the appearance of the country is much the same, it is of a softer nature, and the reef has taken a steeper underlie, carrying good gold.

The strike of the country corresponds with that of the main reef seen on the western side of the range, which, although it contains a little gold, has never yet proved payable, the principal

workings being on reefs which junction with this, and on the main reef at their point of junction. The rocks of the Tokatea tunnel very closely resemble the slates in character, and are, I believe, allied to them. Calcite occurs freely as veins through these rocks, sometimes taking the place of the quartz in the lode-channel, and in two instances a speck of gold has been found in this calcite where the quartz was beginning to come in. It is in the belt of country between the felsite and the main reef that the principal auriferous workings of the Tokatea Range have been situated.

Kapanga Mine.—Unfortunately while I was at Coromandel the pumping machinery of this mine was out of order, and I was not able to thoroughly examine the workings There are two main reefs in this mine, the Kapanga and Scottish, which strike N.–S., and underlie to the westward at an angle of 40°. The country lies at much the same angle, and cross-cuts put in to intersect the reefs pass through different belts of this. In nature it somewhat resembles the Owharoa rock, but is more porphyritic in character at places. Captain Thomas informs me that the same laws hold good about the character of the country here as elsewhere in its influence on the gold-producing properties of the reefs, and that the harder belts where met with have a decidedly prejudicial effect. The old Kapanga Company worked several N.W. leaders, it being in these that the greatest quantity of their gold was obtained, and the present company also intend to work these in their lower levels.

Blackmore's Claim.—This claim, which is situated at the Tiki, is in a class of country which more nearly approaches the character of the Owharoa rock than any other which I have seen at Coromandel. They have a flat reef striking N.E. and dipping westerly, and another, the Home Rule, striking N.W. and dipping N.E., besides several other leaders. The junction of the two reefs has not yet been struck, but they are driving for it, and in the meantime some very good gold has been obtained. There has not yet been enough done here to form a very good idea of what effect the behaviour of the reefs will have on the distribution of the gold.

III.—General Results.

In summarizing the results which have been obtained, it will be best, I think, to follow the points to which you have alluded in your instructions to me, and I shall take them in the same order.

Points 1, 2, 3, 4, are all answered in the geological part of the report, and all bear more or less on the general question, Are the masses of auriferous rock merely locally-altered portions of the great volcanic (trachytic) formation which is widely spread over the area between Taupo and the Bay of Plenty, or are they outcrops of a more ancient igneous formation?

The tufaceous rocks of the Thames rest unconformably on the slates, as shown by the section between the Waiohanga Creek and

the head of Moanataiari Creek (page 12); and the section through the Tokatea Range (page 8), from Beeson's Island to Kennedy's Bay, further supports this. At Tapu the breccia-beds rest unconformably upon the slates, and are a more or less local formation, since, in some cases, the tufaceous sandstones themselves rest on the slates into which auriferous reefs have been traced; but the rock is very hard, and the reefs pinched. With regard to Question No. 4, gold has been obtained in the beds at the Thames to an altitude of 1,500 feet in Nolan's Candlelight Claim; but the tops of the spurs further back appear to be composed of a different class of rock, more approaching a dolerite in character; and this rock in a decomposed state, and very closely resembling some of the Lower Miocene tufaceous sandstones of the North Auckland District, may be traced down the spur between the Moanataiari and Waiotahi Creeks to comparatively low levels, where they are resting unconformably upon the auriferous rocks. There is a further proof of this superposition of the Miocene beds up Mata Creek near Tapu, and again at Coromandel; so no doubt can exist that the auriferous rocks belong to an older series, which is well developed at the Thames, stretches from there to Tapu, may be found at several places between the Thames and Ohinemuri, and crops out again at Te Aroha. A yet younger rhyolitic formation is met with in the Ohinemuri Valley and towards Waitawheta.

As regards the relations of the superficial to the deep-seated workings at the Thames no difference is to be detected. The deep-seated workings are all situated to the south of a large east-and-west fault or slide, and consist of a moderately-hard, white, tufaceous sandstone (the most favourable country for gold), with hard green dioritic belts and beds of jointy or shingly ground, the lowest beds seen being the breccias of Karaka and Hape Creeks, which are again met with at the bottom of the Queen of Beauty shaft. These beds are all dipping, as near as I have been able to determine, W.N.W. at an angle of 1 in 2; and the rocks on the northern side of the slide have approximately the same dip. The breccias are again represented at Tararu Creek, as shown in section (page 12).

It will be at once evident that the diamond drill will form a valuable agent for proving the country at the Thames, for the flat-lying character of the beds offers great facilities for its use, and, when it is considered that the reefs are generally auriferous in certain classes of ground and non-auriferous in others, it will be seen what a vast amount of information can thus be obtained. In using this drill, I should recommend that, first of all, three bore-holes be put down on the flat in a triangle at points sufficiently wide apart to afford a sound basis for determining the exact lie of the strata. After this had been done, an accurate map of the district could readily be prepared, showing the position the

different beds of rock occupy in existing mines, and predicting, within very narrow limits, where they would occur in country which has not yet been worked; but it would entail a very considerable amount of work in the mines, which could be carried on simultaneously with the boring. Beyond this, the diamond drill cannot, it appears to me, be used to advantage, unless locally in the mines, where horizontal boring-machines may give very valuable information; but their use should be directed by a careful compilation of all the information which can be obtained in the mines at present at work, on a map and sections showing the strike and dip of all the reefs, the positions of the various belts of country, and the slides which have been met with in the workings, together with the throw of each and the angle of its underlie. This would entail about two years' work, to be done at all thoroughly, and unless done in a perfect manner would be of no value whatever, as it would give very little more information than I have already been able to compile. The country to the northern side of the slide could be mapped in a similar manner without the aid of the diamond drill, since the outcrops on the surface could be traced, and the workings in the Alburnia and other mines utilized for obtaining accurate dips. The horizontal boring-machine could be employed at the end of the Moanataiari long drive. To prove the auriferous character of the reefs the diamond drill would be of little value.

5. The Te Aroha Range does not consist of an andesitic or trachytic mass flanked on the east by a belt of auriferous country, but, as shown in section (page 16), is composed of a series of stratified tufaceous rocks, which correspond with those at the Thames, and which are continuous through the mountain and on to the ranges on the opposite side of the Wairongomai River. A full description of these beds will be found in the geological section of this report.

6. The seams of bituminous coal mentioned are those which occur in a branch of the Mata Creek, near Tapu, and, so far as yet proved, are not of any very great value. They occur in the Lower Miocene formation, interstratified with tufaceous sandstone, marl, and breccia, similar to the Mahurangi deposits. The greatest thickness reported is 2 feet, and the greatest I have observed is 2 inches.

Referring to your general instruction to obtain any information which would be of use to miners, the second part of my report deals with the characters of the reefs, and those points which appear to have more or less regulated the distribution of the gold; but it will be as well here to summarize the results under M. Moissenet's laws, which I have previously quoted.

1. *Inclination or Underlie.*—The results of observations which have been made on this field show that the mean underlie of the reefs has not in any way affected the distribution of the gold, for

we may either have nearly vertical reefs, as in the Queen of Beauty Mine, which carry good gold, or, as in the case of the Caledonian, the angle of inclination may be 45°, the reefs in different mines ranging between these for their average underlie. When, however, we come to consider the successive inclinations of the individual reefs we find that, wherever notice has been taken, the steeper parts proved the richest, with the exception of the Alburnia Mine, the reason for which, I think, I have satisfactorily shown.

2. *Moderate Hardness.*—It is universally admitted throughout the field that a moderately-hard tufaceous sandstone country is the class of rock most favourable for gold, and that where this is pyritous, and carries small black veins which run into the reefs, rich deposits almost always occur; also that when the reefs pass from this class of rock into either the hard green dioritic belts or into the jointy or shingly ground they are pinched out, flattened, or become poor. I should here remark that, although the presence of pyrites in the enclosing rock is a favourable indication for the occurrence of gold, I do not think the gold has been derived from the decomposition of the pyrites, which appears rather to have been formed contemporaneously with the reefs in the same manner as crystals of tinstone are frequently deposited in the enclosing rocks of lodes of that ore, rendering the country payable for a distance from the lode. The same agents which were employed, probably mineral waters, for the deposition of the quartz and gold, also found their way through numerous small joints in the rocks, decomposing the felspathic constituents, and depositing from solution the crystals and crystalline grains of pyrites. This view is borne out by the fact that, although the rock in the vicinity of the lodes, where they are auriferous, is itself decomposed, the crystals of pyrites which are imbedded in it are all clear and bright, showing that the decomposition cannot be due to surface weathering; and a further proof is found in the fact that the decomposed belts of country frequently occur between two hard beds of dioritic rock which are not decomposed. I do not think that anything tends to prove the late Mr. E. H. Davis's assertion (Geological Reports, 1870–71, p. 69) that the free gold will decrease with the depth of the workings; nor does it appear that the water-level, in the way he seems to have understood it, will in any way affect the deposition of the gold. Captain Hutton's statement (Geological Reports, 1868–69, p. 24), that the small quantities of stibnite, blende, arsenical pyrites, and copper-pyrites which are found in the lodes have been introduced subsequently to the gold, I most thoroughly indorse, since they as well as the fine threads and scales of gold occur entangled amongst quartz crystals in vughs or cavities near the centres of the reefs, making it probable that the reefs have been reopened for their deposition subsequently to the deposition the main auriferous reefs.

3. *Dip* (of the courses or shoots of ore). — It does not

appear at the Thames that any rule can be deduced to the effect that the shoots of ore dip in the same direction as the strata, although they of course more or less approximate to this, since the reefs and beds only vary a few degrees in their strike, and both dip westerly; but the dip of the shoots of ore appears far more frequently to be governed by the direction of the lines of junction of two reefs, as in the Golden Crown and Alburnia Mines, and in the Smile of Fortune at Owharoa. In the case of the Golden Crown shoot in No. 1 reef the dip was in the same direction as the enclosing rock, but it also followed the junction of a hanging-wall leader, so that even this cannot be taken as supporting M. Moissenet's law.

4. *Proper Bearing.*—It is universally admitted at the Thames that any change in the bearing of the lodes is attended by a corresponding change in their auriferous character, but I have not been able to obtain notes of many instances in which the bearings of the rich parts have been accurately noted. The initial fracture of the lodes in the district appears to be on a N.E. line; the main bearings of the different auriferous lodes, however, range between N. 10° E. and N. 80° E., and these vary in themselves along their course. Perhaps the only mine in which the result of this has been accurately observed is the Caledonian, in which Mr. Hicks has pointed out that the average bearing of the reefs is N.N.E., but that these reefs come together and separate several times; also that, when they separate, the reef which goes more to the eastward or follows a N.E. course is the one which carries the gold, while the one passing in a more northerly direction is poor. When the one which has been auriferous turns to the northward to junction with the other it loses its gold, and the northerly one on turning to the east becomes auriferous.

I have thus brought together in as condensed a form as was possible the notes which I have been able to gather in examining the gold fields of the Cape Colville Peninsula. I have carefully avoided any assumptions throughout, and have only recorded those points which have been established by the close observations of the managers, and indicated the channels in which, I consider, these observations would be most advantageously directed in the future. In concluding my report, I may be allowed to express the opinion that nothing I have seen tends in any way to limit the occurrence of gold in depth, but rather should I expect that quite as rich deposits as have yet been found will again occur in the deeper workings. Moreover, the evidence I have been able to gather leads me to suppose that the occurrence of auriferous reefs in depth will not be limited by the boundary of what is now known as the auriferous formation, but that they will be traced down into the slates at places where the physical characters of these rocks are favourable for the formation of reefs, and for the occurrence of gold. The difference between the gold-bearing and non-gold-bearing

beds of the slate series can be well studied at the Tokatea Mine and Tapu.

I append a list of specimens collected, in accordance with your instructions, to illustrate the facts stated in my report.

LIST OF SPECIMENS COLLECTED AT THE CAPE COLVILLE PENINSULA TO ILLUSTRATE REPORT BY S. HERBERT COX.

1. *Hard dioritic band.* Occurs cropping out on beach, just south of flat at mouth of Otohi Creek. No definite stratification can be made out, but there is some appearance of a S.E. dip. The rock is a massive one, several hundred feet in thickness.

2. *Hard dioritic band.* This rock is somewhat coarser than No. 1, which it overlies. The bedding is not very clear.

3. *Decomposed dioritic band.* Is the same as No. 2, but more decomposed. On the beach the rock is in its original state; but on the hill decomposition has set in, and where this has gone on to any extent the rock has taken on a somewhat concretionary structure.

4. *Decomposed dioritic rock.* This rock occurs only a very short distance farther to the south. It is dipping distinctly N.E., and in its lower parts assumes a coarse brecciated character, and sometimes contains large blocks of a dark green rock like No 1. A syncline may occur about here, but we do not see the breccias on the north side of it.

5. *Hard dioritic rock.* Occurs cropping out as some rocks on the beach, and can be traced up a spur in an easterly direction. No stratification can be made out.

6. *Porphyritic tufa.* A decomposed rock which succeeds No. 5, and occupies a considerable area. There are numerous thin veins of a cherty class of quartz traversing this rock at places.

7. *Pyritous tufanite.* A coarse-grained rock, dipping S.W. at an angle of 30°.

8. *Pyritous tufanite.* A fine-grained brecciated rock associated with No. 7, and having the same dip.

9. *Tufaceous sandstone.* This rock occurs overlying the slates between Waiohanga Creek and Tararu.

10. *Soft tufaceous sandstone.* The hanging-wall of Duke's leader in the Kuranui Hill Mine where the reef is poor.

11. *Tufaceous sandstone.* The foot-wall of Kelly's cross-course, in Kuranui Hill Mine, where nearly vertical, 1 foot thick, and auriferous but not rich.

12. *Tufaceous sandstone.* A coarse-grained rock occurring as hanging-wall of Kelly's cross-course, in the same locality as No. 11.

13. *Partially decomposed green dioritic rock.* Was met with in the cross-cut from foot-wall of Duke's leader, in the Kuranui

Hill Mine, to a small steep vein of crystallized quartz, which has been worked, but which the manager could not tell me anything about. He states that payable gold has been got in this class of rock where a rich reef passes into it, but that a poor reef becomes barren on passing into it.

14. *White tufaceous sandstone with black veins.* This is a good class of country, and was collected from the Albion ground, where a reef 6 inches thick was passing through it, containing payable stone.

15. *Partially decomposed rock, similar to No.* 13. In passing into this ground the reef last mentioned is flattened and pinched, splitting up to a certain extent; and here the gold is not payable.

16. *Light-coloured tufaceous sandstone.* Occurs alongside slide in that portion of the Kuranui Hill workings which are wrought from the Caledonian shaft where a small reef has not proved payable, although the manager considers this to be good country. The reef is taking a warp to the eastward at this point.

17. *Dioritic rock.* Met with in Nonpareil cross-cut from main tunnel in Moanataiari Mine, close to No. 2 slide.

18. *Decomposed dioritic rock.* In same locality as No. 17.

19. *Tufaceous sandstone.* In Nonpareil cross-cut, beyond No. 18.

20. *Dioritic rock.* Near Nonpareil shaft, in same cross-cut.

20A. *Harder part of same belt.*

21. *Brown tufaceous sandstone.* Jointy or shingly ground in drive to Italian shaft. The position of this rock on the surface would be between the Moanataiari and Waiotahi Creeks.

22. *Tufaceous sandstone with black veins.* Good country on No. 3 branch-leader, Moanataiari Mine, at 80-feet level.

23. *Tufaceous sandstone with black veins.* Country where "buck" reef is penetrated by gold-bearing leader, Moanataiari Mine.

24. *Hard dioritic rock (partially decomposed).* Occurs at the bottom of the main shaft in the Golden Crown Mine, below No. 1 reef.

25. *Tufaceous sandstone (jointy).* Foot-wall of No. 1 reef, Golden Crown Mine, where pinched and poor.

26. *Pyritous tufaceous sandstone.* Good country in 100-feet level, Golden Crown Mine, where No. 1 reef was rich.

27. *Pinkish tufaceous sandstone (jointy).* Hanging-wall of No. 4 leader, in No. 2 level of Cure Mine, 220 feet from surface, where non-auriferous. This is one of the most mineralized leaders in the Cure Mine.

28. *White tufaceous sandstone with black veins.* Hanging-wall of No. 4 leader, in No. 2 level of Cure Mine, where rich.

29. *Hard green dioritic rock.* From No. 2 level of Cure Mine, near the Waiotahi boundary.

30. *Copper pyrites.* In vein in Cure Mine.

31. *Concretionary tufaceous sandstone.* Belonging to Miocene beds up Hapo Creek.

32. *Dolerite dyke.* Hape Creek.

33, 34. *Fossils.* From boulder in Tararu Creek. Presented by Mr. Adams.

35. *Banded tufaceous rock.* Foot-wall of reef in Reward Claim, Tairua.

36. *Quartz.* From reef in Reward Claim, Tairua; strikes N.–S., and carries gold.

37. *Banded tufaceous rock.* Hanging-wall of reef in Reward Claim, Tairua.

38. *Hard dioritic rock.* Luck's All Claim, in shattered portion of which a drive was put in along reef.

39. *Dioritic rock (partially decomposed).* From drive in Eminence Claim, just above Luck's All.

40. *Diorite (Timasite?).* From outcrop on surface above slide in the Moanataiari Creek.

41. *Diorite.* Forming foot-wall of large reef in Waiotahi Creek.

42. *Diorite.* Up Karaka Creek.

43, 44. *Porphyritic felsite.* Up the Karaka Creek. These rocks, Nos. 43 and 44, while crystalline, do not appear to be dykes, but are associated with cemented and solidified breccias.

45. *Dolerite.* Occurs as boulders in Miocene tufas, which are due to the decomposition of a lava floe or flat of igneous rock.

46. *Soft tufaceous sandstone.* Occurs as patches of decomposed country in the Caledonian Mine, which resemble the unaltered non-auriferous belts. It passes into good ground in the 270-feet level.

47. *Moderately-hard tufaceous sandstone.* This is the good country in the Caledonian 270-feet level.

48. *Tufaceous sandstone with black veins.* The foot-wall of No. 1 reef in 270-feet level, where the gold was dying out.

49, 50. *Quartz.* From No. 2 reef, where rich, at 210-feet level of Caledonian.

51, 52. *Crystallized quartz with stibnite.* In Young American leader where gold was got in Caledonian.

53. *Hard dioritic rock.* From bottom of Waiotahi shaft.

54. *Tufaceous sandstone with black veins.* Hanging-wall of No. 4 reef in Waiotahi mine.

55. *White tufaceous sandstone.* Foot-wall of No. 4 reef in Waiotahi Mine.

56. *Fine-grained tufaceous sandstone.* Jointy or shingly ground, not favourable for gold, which has been traced from No. 1 to No. 3 level, dipping about W.N.W. at an angle of 1 in 2; corresponds with specimen No. 21, from the Moanataiari Mine.

57, 58. *Quartz vein.* In brownish tufaceous sandstone country, Waiotahi Mine.

59. *Quartz reef.* Where auriferous in stopes on No. 5 reef, Waiotahi Mine.

60. *Quartz with pyrites.* From No. 5 reef in main drive of Waiotahi Mine. Is looked upon as a good indication.

61. *Pyritous tufaceous sandstone.* Country in which rich gold occurred in intermediate level of Alburnia Mine, 40 feet above Sons of Freedom level.

62. *Jasper.* From between Paeroa and Te Aroha. Presented by Mr. Radford.

63. *Pumice-sands.* Annie Spur, Owharoa.

64. *Pumice-sands.* Water-race, Owharoa.

65. *Diorite porphyry.* Victoria Claim, Te Aroha; altitude, 2,600 feet.

66. *Diorite porphyry.* From point on road by Farmerville, Owharoa.

67. *Diorite.* On New Find horse-track from Te Aroha Mountain; altitude, 2,600 feet.

68. *Quartz.* From Diamond Gully reef, Te Aroha.

69. *Greenish tufaceous sandstone.* From drive in Specimen Hill, Waitekauri.

70. *Decomposing porphyry.* From drive on south side of Ohinemuri River, Owharoa.

71. *Dioritic rock with pyrites.* Hard belt on tramway at Waitekauri; altitude, 500 feet.

72. *Felspathic porphyry.* From drive on south side of Ohinemuri River, Owharoa.

73. *Dioritic rock.* From Eureka Claim, Te Aroha; altitude, 2,300 feet.

74. *Wood opal.* In drift from pumice-sands, Owharoa.

75. *Coarse-grained tufaceous sandstone.* Good country in Smile of Fortune Claim, Owharoa.

76. *Rhyolitic lava.* From Battery site, Waihi.

77. *Hard pinkish tufaceous sandstone.* From 640-feet level of Big Pump, Thames.

78. *Green dioritic rock.* Ditto.

79. *Hard tufaceous sandstone with thin veins of cherty quartz.* Ditto.

80. *Cherty quartz.* Ditto.

81. *Mineral reef.* Queen of Beauty Claim, Te Aroha.

82, 83, 84, 85. Quartz from Dulcibel Claim, Waihi.

86. *Felsite.* Te Aroha?

87, 88, 89. *Quartz with gold.* Golden Crown Claim, Te Aroha.

90. *Quartz with gold.* New Find Claim, Te Aroha.

91, 92, 93. *Quartz with gold.* Young Colonial Claim, Te Aroha.

94. *Soft tufaceous sandstone with thin veins of quartz.* From low level in Arizona Claim.

95. *Mottled tufaceous sandstone with pyrites.* From New Find horse-track; altitude, 2,000 feet.

96, 97, 98, 99, 100, 101. Intersections of N.E. leaders with N.-S. "flinties" in Karaka Creek, showing how the gold makes in the N.E. leaders near the junction.

102. *Dioritic rock (much decomposed).* The country near Mr. Pepper's new claim, Tapu.

103. *Trachyte porphyry.* From breccia in Mata Creek, Tapu.

104. *Pyritous felsite.* Auriferous country in Gentle Annie Creek, Tapu.

105, 106. *Quartz.* From auriferous reef in Mr. Workman's claim, Waiomio.

107, 108, 109. *Earthy slate.* On eastern side of hard belt of felsite in Tokatea low-level tunnel. The reefs have hitherto proved non-auriferous in this country.

110. *Fine-grained felsite.* Hard belt met with in Tokatea low-level tunnel.

111. *Calcareous earthy slate.* On western side of hard belt in Tokatea low-level tunnel. It is in this rock that the reefs have been found to be auriferous.

112. *Black banded calcareous slate.* From eastern end of intermediate level, Tokatea Mine.

113. *Coal.* From Cabbage Bay.

114, 115. *Dioritic rock.* From Cabbage Bay track, near Bismarck Claim.

116. *Fragment from breccias of coal-measures.* Cabbage Bay.

117. *Auriferous quartz.* Waitekauri.

118, 119. *Mineral lode.* Waiomio.

120. *Dioritic rock.* Thames.

121. *Anamesite.* From spur below Castle Rock, Coromandel.

122. *Trachyte.* From summit of Castle Rock.

123. *Pyritous tufaceous sandstone.* Good country in Blackmore's Claim, Tiki.

124. *Limestone.* From borehole, Kawakawa.

125. *Tufaceous sandstone.* Kapanga Mine, Coromandel.

126. *Hard tufaceous sandstone.* Ditto.

127. *Porphyritic tufaceous sandstone.* Ditto.

128, 129. *Diorite.* From breccias on Kennedy's Bay track.

130. *Tufaceous sandstone.* On Kennedy's Bay track.

131. *Hard tufaceous sandstone.* Ditto.

132, 133. *Calcite.* From vein in felsite in Tokatea long tunnel.

134, 135, 136. *Mineral reef.* Waiomio.

137. *Pseudomorph of quartz after calcite.* Tokatea Mine.

138. *Fine-grained white tufaceous sandstone.* On Waikoromiko track, eastern side of Tokatea Range, near summit.

139. *Decomposed dioritic rock.* Ditto.

140. *Diorite.* Ditto.

141. *Decomposed dioritic rock.* On Waikoromiko track, eastern side of Tokatea Range, near summit.
142. *Diorite.* Ditto.
143. *Anamesite.* Ditto.
144. *Decomposed dioritic rock.* Ditto.

ON CERTAIN ALLUVIAL GOLD WORKINGS IN WESTLAND.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

Wellington, 31st May, 1882.

I HAVE the honour to inform you that, in accordance with your instructions, I have visited the Woodstock new rush, as well as the Ross Gold-Mining Company's ground and the Humphrey's Gully Sluicing Claim, and herewith submit my report on the same.

Woodstock.—The new rush which is at present attracting a good deal of attention at Hokitika is on the Woodstock Hill, where the Ross Road first rises on to the terrace after leaving the Hokitika River, and claims have been marked out on both sides of the road-line for a distance of perhaps three-quarters of a mile towards Ross. It is however in a westerly direction, along an east-and-west line, that the greater number of the working claims are situated, and in this direction claims have been taken up for a distance of nearly two miles.

At the date of my visit about three hundred claims had been marked out, and a population of nearly a thousand men were finding employment in testing the ground. Out of these three hundred claims, sixty shafts were reported to have bottomed on gold which was more or less payable, the yield varying from 4 dwt. to 1 oz. of gold to the load. The thickness of the wash also varied considerably, the limits appearing to be 2 feet and 10 feet, it being from the thinner beds of wash that the richer returns were obtained. The bottom on which the wash rests is generally the brown sands which form the upper part of the Kanieri series, known locally as the "Brighton bottom," but in a few claims it is resting directly on the blue marls of the Kanieri formation.

The sinking is not great, being on an average from 50 to 70 feet, with in a few instances an even less depth, while in the case of the Chinamen's Claim, the furthest one south, which had bottomed on gold when I was there, a depth of 96 feet had been sunk, and the wash struck was thin and poor. The depth of sinking in this case was due to the shaft being sunk on a terrace.

In several cases, the wash struck at the bottom of the shafts was not payable, but on driving better ground was met with, and generally speaking the miners appear to be satisfied with their prospects.

Two or three tunnels have been started from the face of the terrace in order to work claims which have been proved by shafts; and I may mention, as giving an illustration of the value of the ground, that the distance which these tunnels are expected to be driven is about 1,200 feet. Two water-races (Hanlan's and the Nil Desperandum) are in a position to command the greater part of this ground, and, by the system on which the field is to be worked, these should give sufficient water for a large number of claims. Paddocks are being constructed at the heads of the shafts, and water will only be used from time to time, probably about once a week by each mine, to sluice the wash-dirt that has been raised, so that the water can be used by each mine in rotation. Up to the present, no claims are connected with the water, but several are cradling their wash as it comes to the surface with very fairly satisfactory results.

The work which has hitherto been done is not sufficient to determine whether the gold runs in leads or patches, but it is evident that, if in leads, whatever may be their course, there are several of them which may perhaps be only branches of a main one. Mr. Mueller proposes, when the works have progressed somewhat more, to make a survey of the claims, and will show on it all the information obtainable as a guide to the settlement of this question.

As the matter now stands, one is justified in forming a good opinion of the field. Gold has been found at different points over an area about two miles long by a mile wide, and the sinking throughout is not deep, nor is there much water to contend with. The position of the field is all that can be desired, being situated alongside a main road and near to the Town of Hokitika. There is every reason to believe that the whole of the flat between Hokitika and Ross will eventually prove auriferous, and the Hokitika Harbour Board are offering advantageous terms to any party of miners who may prove their reserve to be capable of carrying a population of three hundred miners. Water-power is at once available on the field, and there is every prospect of Woodstock proving, if not an exceedingly rich field, at least one which is capable of supporting a large population.

Ross Gold-Mining Company.—The lease of ground which is now held by this company comprises most of the leases originally held on the Ross flat, and which, during the short time they were worked, gave some very rich returns. The Prince of Wales, Scandinavian, Morning Star, Cassius, and Kohinoor leases are thus held, besides a considerable area of as yet unproved ground.

The works which have hitherto been carried on by the company consist of a tail-race 98 chains in length, which has been brought up from the seacoast, partly by open cutting, partly by tunnelling, and drains the ground to a depth of 75 feet below the surface: this tunnel is connected with the surface at two points by small shafts.

The main shaft which was to work the ground was started on the terrace behind the town, the object being that it should be sunk through what is known as the "terrace bottom," which underlies all the known belts of auriferous wash. This bottom is generally free from water, and it was thought that by sinking here many of the expenses incidental to sinking through wet ground would be avoided; but another difficulty was met with. After sinking a short distance a belt of very fine loose running sand, known as "pug," was cut, and this so much troubled the contractor that he suspended operations while he made arrangements with the company for a special rate for sinking through it, but the delay thus incurred caused the loss of the shaft. This is the more to be regretted, as workshops and a water-wheel had previously been erected at the mouth of the shaft, and thus a considerable amount of expense has been incurred.

It is now proposed to sink a fresh shaft just below the terrace, so as to utilize the machinery by simply turning the water-wheel round, but it seems doubtful whether or no they will then be sinking on the terrace bottom. As, however, they would be certain to reach this at a comparatively shallow depth, and the tail-race will drain the ground to a depth of 75 feet, I think the position chosen will be a good one. The tail-race is considered to have cut the third bottom at the furthest distance to which it has been driven, and the lowest known bottom is considered to be 300 feet below the level of the tunnel.

The company would seem to have every prospect of being successful. They intend to utilize the water-power which is available for the purposes of pumping, hauling, &c. They have reduced their pumping to a minimum by the construction of this long adit or tail-race, and they have a large area of ground, from which 11,543 oz. 9 dwt. 21 gr. of gold are reported to have been taken during a period of thirty-two and a half weeks—the time the original companies worked before being overcome by water with which they were not prepared to cope.

I take occasion here to reproduce a map and sections of the district which were originally prepared by C. Y. O'Connor, Esq., C.E., in 1866, when the question of drainage was before the public. This map is now out of print, and is so valuable as giving information which cannot be now obtained that I am glad of the opportunity of having it reprinted.

Humphrey's Gully Sluicing Claim.—This, which is another of the extended alluvial claims lately granted to companies prepared to incur considerable expense to work ground otherwise unremunerative, is situated on one of the Harbour Board reserves between Humphrey's and McDonald's Gullies, which fall into the Arahura River from the south. It comprises an area of 98 acres, in which several reserves have been made for small sluicing claims which were previously in existence, and which are still to be

worked, the company agreeing to supply them with water at a fixed rate.

From one of these parties a water-race, in course of construction, has been purchased, and this it is intended to enlarge and extend so as to bring in at least fifty Government heads of water, and by means of a tunnel, one mile or less in length, it is proposed to reduce the total length of the race by about three miles. From the engineer's report there appears no doubt that at least fifty heads of water can be readily obtained, and the race is to be made of sufficient capacity to carry double that amount.

The position of the company's lease is exceedingly good, the whole of the wash being well above the flats of the Arahura River, and tail-races can be constructed wherever it may be found most convenient. The thickness of wash varies from 100 feet to 300 feet over the whole of the lease, and, as a result of several trial washings in a tin dish, taken at random from different parts of the claim, I am pleased to be able to state that in no instance was a dish washed out without showing one or two colours of gold, and in several cases there was a good-looking prospect. This is one of the points on which the company chiefly rely as a test of the value of their ground, and I was curious to see if any dish of wash could be got which would not show a colour, so that we tried prospects at all points of elevation, with the results which I have cited. The gold does not appear to lie on any bottom, but to be disseminated throughout the entire wash, being sometimes richer and sometimes poorer, but in all cases payable if large quantities are to be treated. The gold is coarse, pieces up to ½ dwt. occurring, and at a trial washing which was made a short time ago, when, owing to heavy rains, water was plentiful, 110 loads of dirt gave 14 oz. of gold. The day I was there I saw some miners, who were sluicing on a small scale, clean up their top boxes after three weeks' work, with the result that about 7 oz. of gold were obtained, and probably an equal quantity would be got from their remaining boxes.

There is no doubt that works of this sort require the outlay of a large amount of capital, and in this case the estimated cost of the water-race alone is £15,000: when, however, we take into consideration the quantity of auriferous ground which is there, and which only awaits the introduction of water for its treatment, we feel assured that the judicious outlay of capital, were it far greater than this, could only be attended with good results. It is moreover opening up a new branch of the gold-mining industry on the West Coast, and I have no doubt, if similar concessions are granted to other companies, that before long we shall see many more large sluicing claims at work, and ground being turned over which in small areas could not be worked remuneratively.

ON THE SHAG VALLEY.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

Wellington, 31st July, 1882.

I HAVE the honour to inform you that, in accordance with your instructions, I have examined the country between Palmerston and Waihemo, and herewith submit a map of the district showing the approximate boundaries of the different formations.

Foliated Schists.—The oldest rocks met with in the district are the foliated schists. These consist of alternations of argillaceous and micaceous schists, in which segregations or laminæ of quartz, generally parallel to the bedding of the schists themselves, are not uncommon. They are also traversed by veins and reefs of quartz.

These schists appear generally to occupy the low-lying country or downs which flank the Shag River on the southern side, and are rarely met with to the north. They rise gradually to form a table-land of moderate elevation, which is cut by gullies or gulches, the sides of which are very steep, and in many of these notable deposits of alluvial gold have occurred. In a few instances minor peaks rise from this table-land.

These rocks occupy both sides of the Shag River after passing the Waihemo Grange, in the direction of the Waihemo settlement; and before reaching Sir D. Bell's homestead they are replaced on the road by the slates and sandstones of the next formation. Towards Palmerston the only place at which the schists are seen crossing the river is at what is called the stone section, where they form a low hill, round which the Shag River takes a sharp turn. They strike N.N.W., and dip E.N.E. at an angle of 15°.

Lower Carboniferous and Upper Devonian Rocks (*Maitai and Te Anau series*).—These rocks are the next which are seen in ascending order, and their boundaries can be seen on the accompanying plan. They consist, as is well known, of a series of breccia-beds, interstratified with slates and sandstones, as the lower or Te Anau series, and of green and purple slates and sandstones, with which bands of an argillaceous silky slate and a blue somewhat crystalline limestone are interstratified, in the upper or Maitai series.

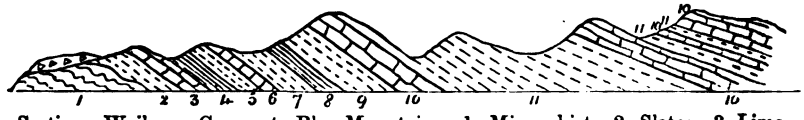
The Upper Devonian or Te Anau beds occupy the second range of hills on the north-east side of the Shag Valley, and are separated from the Lower Carboniferous slates, sandstones, and limestones by a fault which strikes N. 65° W. magnetic, and can be traced by a line of depression in the country which extends from the road-line near Sir Dillon Bell's station to the sea, passing down Woolshed Creek and alongside Clover Hill and Puketoitoi until it reaches the mouth of the Shag River. The down-throw of this fault is to the south-west, and close alongside it the slates and sandstones of the Te Anau series, which are

striking N.N.E., and dipping E.S.E. at an angle of 45°, are highly contorted and more or less metamorphosed.

On the down-throw side of the fault the rocks of the Maitai series form the first range north-east of the Shag Valley, stretching from the Waihemo Grange in a south-east direction until they are overlaid by the Cretaceo-tertiary conglomerates; while to the north-west a repetition of the Te Anau beds occurs, the fault being thus somewhat less distinct owing to the resemblance of the beds on each side of it.

The south-east portion of this fault, from what is known as the limestone fence to the sea, is very clear. The strike of the Maitai rocks is N.N.E., and the dip E.S.E. at angles varying from 50° at the north-west end to 35° further to the south-east.

A very interesting section can be traced in this direction from the Waihemo Grange to the Blue Mountains, which is as follows:—



Section—Waihemo Grange to Blue Mountains. 1. Mica-schist. 2. Slates. 3. Limestones. 4. Sandstones. 5. Slates. 6. Limestones. 7. Slates. 8. Sandstones. 9. Slates. 10. Limestones. 11. Slates. 12. Subangular gravels.

—from which it is apparent that five distinct beds of limestone occur interstratified with the slates and sandstones, and each of these belts is cut off by the fault, no trace of limestone being found on the north-east side of it. It will be evident from this that the down-throw has been very great, and that from a structural point of view this fault has exerted great influence on the configuration of the country.

Cretaceo-tertiary Series.—The next overlying rocks are the quartz conglomerates of the Horse Ranges, towards the upper part of which the coal seams of the Shag Point Mine occur. These beds are striking N.N.E., and dipping E.S.E. at an angle of 10° over the greater part of the Horse Ranges from the coal reserve towards Hampden; but along the range on the north-east side of Woolshed Creek, which is on the strike of the fault, they are tilted at high angles and greatly contorted. Overlying these come the concretionary sandstones which occupy the beach near the Shag Point Coal Mine, and with these are interstratified clay-marls and shales, in which beautiful crystals of selenite are sometimes very plentiful. These beds are again met with forming low downs between the schists and Maitai limestones above the stone section on the Shag River, and a further repetition of them occurs in the low country south-west of the line of fault between Palmerston and Woolshed Creek. It is therefore very probable that a great extension of the coal-bearing formation occurs below the Palmerston flat.

Survey of New Zealand

ECTOR, C.M.G., F.R.S., DIRECTOR.

SKETCI

VALL

REPORT BY S.HE

Pliocene Beds.—A series of subangular gravels skirt the range from the north-west side of Janet's Peak until passing the Grange, which appear to be composed of *débris* brought down by lateral torrents from the ranges and deposited as fans. They obscure the Cretaceo-tertiary series, which probably occurs all up the Shag Valley for some considerable distance.

Recent.—The only beds which come under this head are the deposits of the Shag River which form plains quite distinct from the Pliocene ones just alluded to. No special points of interest attach to these.

BROCKLEY COAL MINE AND SURROUNDING DISTRICT.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

Wellington, 15th August, 1882.

I HAVE the honour to inform you that, in accordance with your instructions, I have visited the Brockley Coal Mine, and that I took the opportunity of a spare day to pay a flying visit to the Rakaia Gorge and Acheron River coals.

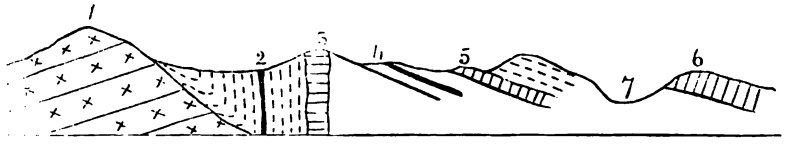
The Brockley coal-seam is situated near the Hororata River, at the south-eastern end of the area of brown coal shown on Dr. von Haast's map of the Malvern Hills District (Geological Reports, 1871–72, p. 88) as extending from the Selwyn to the Hororata River on the north-east side of the Wairiri Valley; and in section 4 of the same report he shows, at this point, beds of brown coal altered by dolerites.

I have practically very little to add to this report from a geological point of view, except to state that the Brockley Mine is worked in a vertical seam 6 feet thick, striking W. by S., included between a dyke (which also strikes W. by S.) and the quartz porphyries which form the ridge between Brockley and Washpen Creeks, called Pullwool Peak on Dr. von Haast's map.

The tilting of this seam of coal by means of the dyke has taken place during more recent times, probably contemporaneously with the formation of the dolerites of the Harper Hills, and it has been attended by a local alteration in the character of the coal. When this is considered, we are enabled to arrive at some estimate of the possible quantity of altered coal in the Brockley seam, for it is at once evident that beyond the boundaries of the dyke along its strike no alteration will have taken place, and this is borne out by the occurrence of seams of brown coal in the direction of the Selwyn. It is obvious that, in whatever manner the coal-seam may have been dislocated between the dyke and the porphyries, it cannot have a greater extent than the superficial distance between these two rocks, and, if for convenience of calculation we assume that the coal has been inverted so as to lie vertical and parallel to the dyke throughout, we get the greatest amount possible.

This would give us an outside measurement of 120 chains by 35 chains, or about 420 acres of coal 6 feet thick, equivalent to 2,520,000 tons; but this quantity could not be taken as a basis for any calculations, since up to the present time the coal has only been proved for a distance of half a mile along its strike, and the depth of 35 chains (2,300 feet) thus assumed would, even if the coal occurred to that depth, make the cost of working too great to prove remunerative for many years to come. Allowing, then, that coal has been traced for a distance of half a mile, and may be worked to a depth of, say, 1,000 feet, we should have 300,000 tons of coal available in the Brockley Mine.

To the southward of the Brockley Mine there is another outcrop of altered coal, known as Ayers's (Lee's) Mine, which is dipping to the southward, at an angle of about 30°. At this point there are two seams, one of which was reported to be 6 feet thick when it was opened out, but the drive had fallen in, and when I visited the locality, although some trouble had been taken to clear the place up, the outcrop only could be seen, and a fair estimate of the quality of the coal could not be made. There is, however, one seam at least 4 feet thick, and another about 2 feet in thickness dipping towards the flat, and the analyses of these coals as seen in the accompanying table (pages 60, 61) show them to be of very good quality. They are overlaid by a dolerite flöe, as shown in the following section :—



Section through Brockley and Ayers's Mines. 1. Quartz porphyries (Pullwool Peak). 2. Brockley Coal Mine. 3. Dyke. 4. Ayers's (Lee's) coal mine. 5. Dolerite flöe. 6. Harper Hills. 7. Wairiri Valley.

—which may either belong to the contemporaneous volcanic series of the coal-measures (melaphyres), or to the more recent doleritic one of the Harper Hills, but most probably is of the former age. This rock appears to have altered the constitution of the coal where exposed, and it is quite probable that coal of the same character may extend some distance to the dip, but the nature of the country will make it necessary to work this by shafts or very long tunnels, since it dips towards the Wairiri flats; a series of hills, however, intervening between the outcrop and the flat, the rocks of which overlie the coal-measures. It is evident that no estimate can be formed of the extent of the altered coal in this direction beyond this: that it may occur for 120 chains along the strike, and extend to the dip indefinitely, but how far actual work alone can show.

In Washpen Creek, on the north-western side of Pullwool

Peak previously referred to, altered coals again occur, striking N.–S., and standing vertical; but at a short distance from the creek the measures are dipping to the west at gradually-decreasing angles, although they are very shortly overlaid by the terrace gravels of the Hororata and Rakaia Rivers, which are continuous in the flat country until the Rakaia Gorge is reached.

Dr. Hector, in reporting on this district (Geological Reports, 1870–71, p. 47), says of Washpen Creek, "Under the sandstone, ironstone beds appear, and in that part of the stream opposite Redwood [Rockwood] Station the same ironstone strata are seen to form the floor of the valley, interbedded with coarse quartzose grits, finely laminated shales, and ten well-defined but thin seams of coal, the thickest being only 2 feet 9 inches."

At the Rakaia Gorge Dr. von Haast reports the occurrence of two thin seams of anthracite, 2 feet 2 inches and 2 feet 4 inches thick respectively, besides which there are two thick seams of an altered brown coal of good quality, as may be seen by the accompanying analyses, by Mr. Skey, of samples which I collected. They have, however, a high percentage of water, notwithstanding the fact that the proportion of fixed carbon to hydro-carbon is large, and the coal does not stand the weather as well as that from Brockley, although it is superior to the average coals of the Malvern Hills. These seams, which are about 10 feet thick each, are arranged as a rather steep syncline, the axis of which strikes about N.E., in the direction of the Brockley and Rockwood seams, and it is quite possible that the coals may be continuous below the flat in this direction, flanking the Four-Peak Range to the south-east; but this can only be proved by boring.

Mr. Gerard, the proprietor of these Rakaia seams, has, I understand, expressed his intention, in the event of a railway being constructed through the Wairiri Valley, of laying down a tramway to connect his coal with it—a work of some magnitude, since twelve to fourteen miles would have to be constructed.

About six miles from this point, in the valley of the Acheron River, a seam of anthracite, owned by Mr. Murchison, occurs. This seam, which is 4 feet thick, is of first-rate quality, being the best which has been found in the district. A previous analysis of a sample collected in 1869 by Dr. Hector gave 88·91 per cent. of fixed carbon, or an evaporative power of 11·5, but the sample which I brought has a large percentage of ash, and so does not give as good returns to analysis.

This seam, which has previously been reported on by both Dr. Hector and Dr. von Haast, is striking N.–S., and dipping west at an angle of about 30°, and is a parallel belt to the Rakaia syncline, the same remarks applying to the country between the two points as I have already made concerning that lying between the Rakaia and Brockley, but here the length along the strike is limited by Mount Hutt on the one side and the High Peak Ranges on the

other. Coal is reported to occur for two miles further up the Acheron, but Dr. Hector reports (Geological Reports, 1870–71, p. 49) that it is of inferior quality.

To summarize the results of my trip, it appears that four classes of coal occur in the district, as follow :—

1. *Anthracites.* Of these, the best seam is undoubtedly that at the Acheron, which is 4 feet thick and also of the best quality, having an evaporative power of from 8·5 to 11·5. Besides this there are thin seams in the Brockley Mine, and also in Ayers's (Lee's) Mine, as well as at the Rakaia, which might be worked in conjunction with other seams of coal.

2. *Altered brown coals in which the percentage of water is not high*—amongst which the thick seam in Ayers's (Lee's) Mine and the Brockley 6-feet seam may be classed. They are of good quality, burning freely and not being affected by the weather, but the sample from Mr. Ayers's mine is the best. These correspond with the better class of pitch coals.

3. *Altered brown coals with high percentage of water*—including the large seams of coal at the Rakaia Gorge. These coals have a lower evaporative power than the foregoing, and do not stand the weather so well; they are, however, of better quality than the ordinary brown coals.

4. *Brown coals*—which are largely represented in the Malvern Hills, but are not found amongst the seams which I have examined. They have a high percentage of water and hydro-carbons, and a far lower evaporative power than any of these.

The extent of these altered coals is not assured, as I have previously pointed out, and without the knowledge which can be obtained by means of boring no estimate of quantity can be made. The estimate given of the quantity of coal in the Brockley Mine is, however, only a small proportion of what probably occurs in the district, and the coal in Mr. Ayers's seam adjoining it is of yet better quality.

The following analyses have been made by Mr. Skey of the samples of coal which I collected :—

1. *Anthracites.*

	Acheron.	Ayers's: Thin Seam.
Fixed carbon	65·80	52·01
Hydro-carbon	5·38	3·69
Water	4·57	4·89
Ash	24·25	39·41
	100 00	100·00

Evaporative power: Acheron, 8·50; Ayers's, 6·76.

2. *Altered Brown Coals in which Percentage of Water is not high.*

	Brockley (per Mr. Cox).	Brockley (per Mr. McMillan).	Ayers's: Thick Seam.
Fixed carbon ..	49·99	53·29	62·21
Hydro-carbon ..	35·42	32·04	18·99
Water	11·79	12·65	5·20
Ash	2·80	2·02	13·60
	100·00	100·00	100·00

Evaporative power: Brockley (Cox), 6·49; Brockley (McMillan), 6·76; Ayers's (thick seam), 8·08.

3. *Altered Brown Coals with High Percentage of Water.*

—	Rakaia Mine.		Rakaia Mine: Upper Seam.	Outcrops of Coal in Cliff on Rakaia River.	
				No. 1: Lower Seam.	No. 2: Upper Seam.
Fixed carbon ...	46·06	46·70	44·43	45·30	35·30
Hydro-carbon ...	28·80	24·99	26·08	25·95	27·42
Water	18·18	18·42	19·53	26·15	18·28
Ash	6·96	9·89	9·96	2·60	19·00
	100·00	100·00	100·00	100·00	100·00

Evaporative power: Rakaia Mine, No. 1, 5·98; No. 2, 6·07; Upper Seam, 5·77. Lower Seam on cliff which has been worked to a small extent, 5·88; Upper Seam, ditto, 4·59.

It will be of interest to reproduce here a report by the Railway Department on the comparative work done by Westport, Shag Point, and Brockley coals, from which it will be seen that the tonnage per train-mile for 1 lb. of coal consumed, which is the best test of the comparative value of the coals, is as follows:—

Westport	8·22
Brockley	5·63
Shag Point	3·74

the evaporative power of the different coals being,—

Westport	8·2
Brockley	6·5
Shag Point	5·4

NEW ZEALAND RAILWAYS.—HURUNUI-BLUFF SECTION.

COMPARATIVE STATEMENT of BROCKLEY, SHAG POINT, and WESTPORT COAL used on Locomotives.

—	Date.	Engine No.	Class.	Mileage.	Coal consumed.	Rate per ton.	Value.	Average Consumption, lb. per mile.	Cost in pence per engine-mile.	Cost in pence per ton-mile.	Average Tonnage per train-mile.
	1881.				cwt.		£ s. d.				
Brockley ...	Apr. 18 to Apr. 30	84	J	1093	400	22/	22 0 0	41·00	4·83	·025	230·82
	1880.										
Shag Point ...	Sep. 20 to Oct. 16	84	J	2167	1070	13/	34 15 6	55·30	3·85	·022	207·11
	1881.										
Westport ...	Apr. 11 to Apr. 30	86	J	1649	430	24/	25 16 0	29·20	3·75	·020	240·10

ON THE DISTRICT BETWEEN COLLINGWOOD AND BIG RIVER.

REPORT BY S. HERBERT COX, F.C.S., F.G.S., ASSISTANT GEOLOGIST.

Wellington, 28th December, 1882.

I HAVE the honour to inform you that, in accordance with your instructions, I left Wellington per s.s. "Wanaka" on October 2nd, arriving in Nelson on the following day. On October 5th I left for Collingwood overland, arriving there on the 7th; on the 8th I visited the caves to inspect the work which Mr. Park had been carrying on in search of moa bones, and we moved camp to Collingwood the same day. On Monday, October 9th, we moved camp to the Tomatea Bluff, and spent the following week examining the country between Collingwood and Pakawau, to which place I moved on Saturday, October 14th. I stayed at Pakawau until Tuesday, the 17th, when I again moved camp to the West Wanganui Old Store, from which point I examined the country round until Monday, October 23rd, when I went to the Golden Ridge, returning to West Wanganui on Saturday, October 28th. On the 31st October we moved camp to the mouth of the Turimawiwi River, and worked from this camp to Big River and up the Turimawiwi until November 5th, when we moved up the Turimawiwi to the Gorge. From this date until the 12th we moved camp day by day, working up the spur range between the Turimawiwi and Anatori Rivers until we reached the summit of one of the peaks of the Wakamarama Mountains, and found that it was impracticable to reach the Gouland Downs by this route. We then returned to our former camp, and thence to Collingwood,

arriving there on Monday evening, November 13th. Tuesday, Wednesday, and Thursday were wet, and on Friday I visited the Wallsend Colliery on behalf of the Mines Department, and on Saturday, November 18th, I went to the Red Hill Mine. On the 20th I left Collingwood for the Gouland Downs, returning to Brown's River on the 23rd; and on the 24th I rode over to Cole's Gully, and examined the works which had been carried on by the Keep It Dark and Hope Companies, returning to Collingwood the same night; and on Saturday, November 25th, I visited the silver mine at Kaituna. On Tuesday, November 28th, I left for Nelson, arriving there on the evening of the 29th, and Wellington on the morning of the 1st December.

Report.

My work during this trip was chiefly devoted to revising the boundaries of the different formations occurring in the area examined, which is bounded by the Awarutatoa or Big River from the Gouland Downs to its mouth, by the Aorere River from the Gouland Downs to its mouth, and by the coast-line between these two points, together with a special examination of the Golden Ridge, Keep It Dark, Red Hill, Hope, and Kaituna Mines. The formations represented are as follow:—

Granite.

Metamorphic Rocks.—Crystalline limestone, gneiss, and mica-schist.

Lower Silurian.—Slates, sandstones, and breccias.

Lower Greensand.—Grits, conglomerates, sandstone, and coal (lower coal-measures).

Cretaceo-tertiary.
- Sandstones, shales, and brown coal (upper coal-measures).
- Calcareous sandstones.
- Limestone.

Lower Miocene (?).—Blue marls.

Pliocene.—Old river-gravels.

Recent and Pleistocene.—Recent river-gravels, raised beaches, and blown sands.

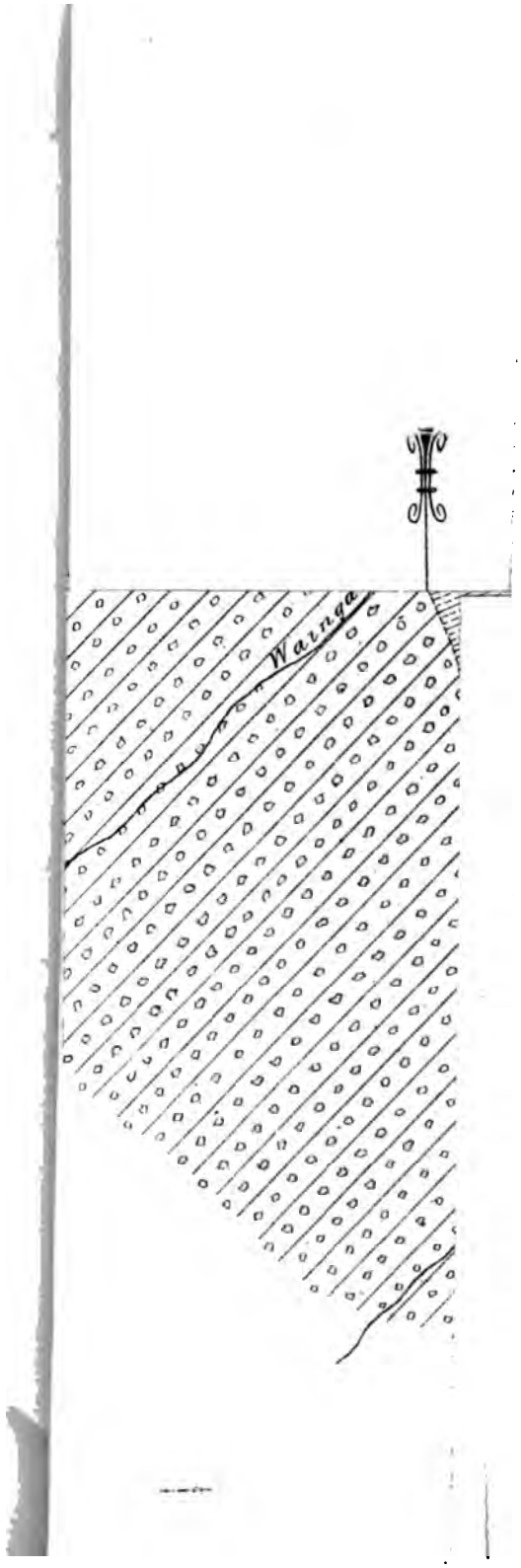
Of these the boundaries are generally well defined, but the exceedingly imperfect character of the map with which I was furnished, and which was the best to be obtained, rendered it necessary to fix several points in the course of my work from which to construct a reconnaissance map, so that the boundaries cannot lay claim to strict accuracy; they are, however, correct as referred to the rivers and streams laid down, and when these are properly surveyed and maps published there will be no difficulty in constructing an accurate map from the information to hand.

Granite.—Two belts of granite exist in the area under consideration, the rock from the two points being possessed of such dissimilar characters that no difficulty can be experienced in dis-

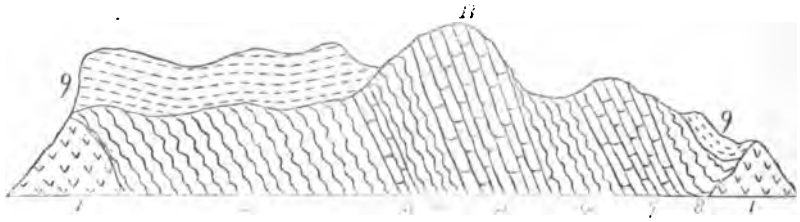
tinguishing between them. The first of these is the belt which forms the well-known Rocks Point, between Heaphy and Big Rivers, and forms the coast-line until reaching Karanga Point in a northerly direction, where it is overlaid by calcareous sandstone which occurs as a narrow strip along the coast. It forms an isolated hill close to the coast between Karanga Point and Big River, and, crossing Big River at the head of the mud flat, extends to the Turimawiwi, the first gorge of which river is cut through this rock. It forms a conical bush-clad hill on the northern side of this river, from which the Independent Creek, a branch of the Anatori River, takes its rise; and from this point northward the granite does not appear at the surface until House-roof Hill, near West Wanganui Harbour, is reached, and it is again met with as a small outcrop at Pakawau. Another outcrop of the same granite appears near the mouth of the Kaituna River, and extends through the creek up which the so-called Kaituna silver-mine is situated. The special characteristics of this granite are the entire absence of macroscopic crystals of hornblende, and the occurrence of black mica, the main constituents of the rock being felspar-quartz and black mica. This rock varies in texture from a very coarse porphyry in which the felspar crystals are from one inch to four inches long,—in which form it occurs in the Turimawiwi and Big Rivers, and extends from there to Rocks Point,—to a fine-grained granite having a more gneissoid structure, which occurs at House-roof Hill, Pakawau, and Kaituna.

The second belt is the one which forms Lead Hill and Mount Olympus, crops out again at Waingaromumu, and continues from Tata Island in the direction of Separation Point; it may also be traced on to the Gouland Downs, where it forms a hill at the head waters of the left-hand branch of Big River. Its special characteristic is the presence of hornblende throughout its mass, and the occasional occurrence of schorl, as at Tata Island. It is more truly a syenitic gneiss granite than anything else.

Metamorphic Rocks.—In my report on the Collingwood District (Geological Reports, 1881, p. 44), I provisionally referred the beds of crystalline limestone and bituminous and hornblende schists, which occur in the Parapara River, to Lower Silurian age, on account of the resemblance which they bear to the Mount Arthur series, described by Mr. McKay (Geological Reports, 1878–79, p. 123); but it now appears somewhat doubtful whether or no they should be considered as belonging to this formation, and it will have yet to remain an open question. The same series of beds are met with on the western side of the Aorere River, extending along the flanks of the range from Kaituna River to Pakawau, being overlaid high up on the range by the coal-measures, which rest unconformably upon the upturned edges of these beds. The series of rocks under consideration consist chiefly of schist and limestone striking N.E. by E., and dipping N.W. at


Wainga

very high angles, indeed standing nearly vertical. The lowest beds seen are those which are exposed in the creek, a branch of the Kaituna River, up which the veins of galena and pyrites occur known as the Kaituna silver-mine. These beds consist of a greenish-coloured fine-grained mica-schist, with interstratified bands of a more gneissose character, and they continue uninterruptedly until the belts of limestone which cross the upper tramway to the coal-mine are reached. These belts of limestone, which are not in either case very thick, are overlaid by reddish-coloured schists, which are continuous to the coal-mine, and may be traced along their strike to the foot of the hill between Ruataniwha and Limestone Creeks. A belt of crystalline limestone then comes in, which is found in Limestone Creek and near the mouth of Plumbago Creek, and, striking from there N.E. by E., forms the mass of Mount Burnett, which is composed of this rock to its summit. Passing up Plumbago Creek the limestone is lost at some distance from its mouth, and another belt of the reddish-coloured schist comes in, the bed of the creek becoming flatter and smoother until this is passed, when another belt of white crystalline limestone is met with, which is uninterrupted along its strike as far as the hill at the back of Waikato Inlet, being overlaid in Plumbago Creek by the coal-measures, in which the coal has been locally altered to graphite. This limestone is again succeeded by mica-schist of various degrees of coarseness, which may be followed to Pakawau, where it is bounded by the outcrop of granite before mentioned.



Section on line A–A. 1. Granite. 2. Mica-schist. 3. Crystalline limestone. 4. Mica-schist. 5. Crystalline limestone. 6. Mica-schist. 7. Crystalline limestone 8. Mica-schist. 9. Lower coal-measures. B. Mount Burnett.

This belt of country forms the only exposure, in the district under consideration, of the metamorphic schists and limestones which I have hitherto referred to Lower Silurian age, and they have no visible connection with any other beds except the coal-measures, which, being so much younger, are of no value in determining their age. It would appear, however, as if these beds must be of greater antiquity than previously supposed, because the next series to be described, which we have many reasons for considering of less age, have graptolites associated with them at one or two points, and thus will have to be considered as of Lower Silurian age themselves.

There is yet another point connected with these metamorphic

rocks which is open to consideration, and that is the relations of the limestone which I have described. I have previously pointed out (Geological Reports, 1879–80, p. 2) that the crystalline limestone of the Riwaka Range appears to rest unconformably on the schists, &c., which form the main mass of the mountains, and it is quite possible that the limestones near Collingwood may in reality have a similar association, notwithstanding the fact that they appear to be interstratified with the schistose rocks. This point, however, is one which requires very careful mapping to determine, and must remain unsettled until greater facilities exist for a study of the rocks, or sufficient time can be devoted to an accurate survey of them.

Lower Silurian.—These beds consist of sandstones and slates, which form the main mass of the Wakamarama Mountains, and may be traced from the Kaituna River to the Gouland Downs on the eastern side, and from Baldy Hill to Big River on the western side of the district. Over the greater part of the area they have a N.–S. strike, and a westerly dip at angles varying from 30° to 45°; but on the eastern side of the area occupied by these rocks the dip is much steeper than it is towards the sea and in the neighbourhood of the Golden Ridge Mine. The lowest beds exposed are dark-blue slates, and hard white cherty sandstones, which form the Wakamarama Mountains from a N.–S. line through Valley Peak in an easterly direction towards the Kaituna River: these are generally dipping west at angles over 45°, and as we pass across the strata, from Back Peak towards the Golden Ridge, we find that the dip of the beds is generally less than 45°; and when the Golden Ridge is reached the prevailing dip is 30° west, but the country waves, and a syncline is passed, the beds beyond this becoming somewhat steeper again.

Section on Line B–B. Lower Silurian: 1. Metamorphic schists; 2. Blue slates; 3. Cherty sandstone; 4. Blue slates; 5. Cherty sandstone; 6. Dark-coloured slates; 7. Cherty sandstone; 8. Carbon-slates (graptolites); 9. Cherty sandstone breccia. Cretaceo-tertiary: 10. Calcareous sandstone; 11. Limestone.

The country between Back Peak and the Golden Ridge is comparatively bare, the scrub and fern which covered it having been repeatedly burned, and we are thus enabled to gain a fair knowledge of the country. What we find is that the strike of the beds has operated largely in forming the physical features of the land, and that the main trend of the country is N.–S., spurs and creeks both following this direction, and where the rivers and creeks have cut through the spurs they have formed very precipitous gorges. The hard belts of cherty sandstone, to which I have alluded, appear

throughout the district to have resisted the eroding action of the weather and rivers, and stand up in bold relief forming the spurs, while the softer slates occupy the lower ground between the ridges, and have generally determined the course of the smaller tributary creeks feeding the main rivers, which cross the strike of the rocks obliquely and become exceedingly gorgy at no great distance inland. The breaking-down of these ridges of hard sandstone has scattered a *débris* of this rock over most of the low ground between the spurs, and where boulders are not seen there is frequently a deposit of coarse sand, derived from the wearing-down of the same rocks, so that the outcrops of slate are generally much obscured, which is apt to lead one to the conclusion that they are poorly represented. When, however, we come to study the beds of the rivers, we find by the shingle that a large proportion of the country must be composed of slate, and moreover the slate itself may be seen *in sitû* at many places up the rivers. The Golden Ridge Mine is situated in one of these belts of slate, the rock in the mine having an earthy nature, while the same rock a little higher in the section has a laminated structure, a black colour, and contains graptolites (which I unfortunately did not notice until pointed out to me by Dr. Hector on my return to Wellington, and so did not make any collection); while the lower beds as exposed in Slaty Creek are hard blue siliceous slate, similar to those which occur lower in the section.

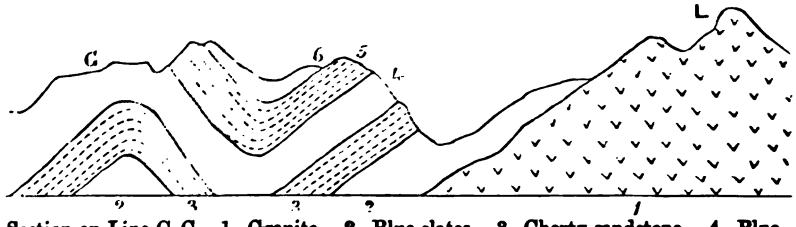
These beds are overlaid by a grey cherty sandstone, which near its base contains occasional angular fragments of the same class of rock, and as we rise in the section these become more and more frequent until at length the rock becomes a true sandstone breccia, as which it may be traced round the flanks of the hills to Malone's Creek, and again on the ridges by the left-hand branch of Slaty Creek, where it has weathered to some most remarkable isolated pillars of the rock. At Malone's Creek it has formed the bottom of some of the alluvial workings.

Another belt of slate overlies this, which may be seen in the Anatori River, Kokopua Creek, and Friday Creek, at which latter place a reef was worked for a short time, but without any great success.

The strike of the black slates, with which are associated the auriferous reefs, would carry them through Sandhills Creek, crossing the left-hand branch, and thence through the head waters of the Anatori River to the western side of the Gouland Downs, a district which is very steep and mountainous, in many cases clad with a dense bush, and, being very inaccessible, has not yet received the attention it deserves as a reefing district. The nature of the country throughout, on this western side especially, is such as may be considered extremely favourable for the occurrence of reefs. It consists of alternations of hard and soft bands of strata, the harder of which are exceedingly siliceous; they are dipping at comparatively low angles, and where reefs have as yet been

found they are crossing the strike of the beds, so that all the requisites for the formation of reefs are there. When it is added that in many cases the rocks themselves are highly charged with pyrites, and that reefs have been found in which payable gold occurs, there is every inducement to prospect the country, especially along the line which I have indicated.

In the main depression of the Gouland Downs themselves the beds have a more N.N.W. strike, and form a syncline; they are also composed of a harder class of slate than that with which the auriferous reefs, hitherto found, are associated, but like them are interstratified with siliceous sandstones: they in fact closely resemble the slates of Slate River.



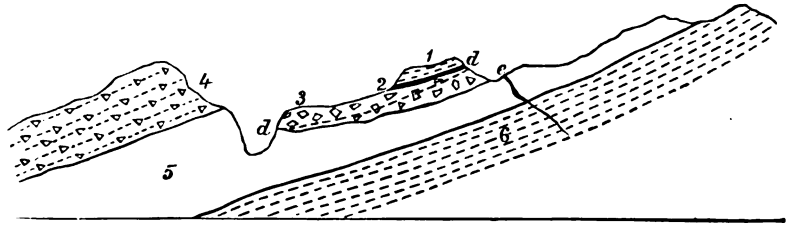
Section on Line C–C. 1. Granite. 2. Blue slates. 3. Cherty sandstone. 4. Blue siliceous slates. 5. Cherty sandstone. 6. Hard blue slates. L. Lead Hill. G. Gouland Downs.

They are traversed by reefs and leaders of quartz which have not, however, as yet proved sufficiently auriferous to pay; but when we consider that the quartz wash of the Quartz Ranges, which may be traced as outlying patches along the hills through Golden Gully to the mouth of the Parapara River, as alluded to in my report on the district (Geological Reports, 1881, p. 55), has in all probability been brought from here by the Aorere,—which, at that time flowing at a much higher comparative level, emptied itself into the sea at the Parapara, or at least in that direction,—there is every reason to suppose that auriferous reefs yet remain in the Gouland Downs, more especially on the western side, where, as previously pointed out, the softer slate will yet survive.

In speaking of this formation it will be proper to give a description of the mines worked in it, which are at present confined to the Golden Ridge claims and others in close proximity to it.

The Golden Ridge Mine was originally started to work some auriferous cements composed of angular fragments of slate, sandstone, and quartz, frequently cemented with oxide of iron, which occur resting on slates and sandstones close to the main drive on the reef in the original Golden Ridge Mine. It is overlaid by a seam of coal about 4 feet thick, which has no great extent at this point, but occurs as outlying patches in various localities to the south and west; it is situated at an altitude of 150 feet above the huts, or 700 feet above sea-level, and dips north at an angle of 01°. This cement appears tobe an old slope deposit derived from

the reef by the degradation and wearing-away of the rocks of the hill. The gold never occurs in it in a free state: that is to say, if a dish of the cement were washed without crushing very little gold would be obtained; but all the gold—and the cements were very rich—was contained in quartz, which had to be crushed before any good returns could be made. The reef itself was discovered by careful prospecting in the cements, and was followed up by shode stones from the creek to the outcrop, it being found that the greater quantity of auriferous quartz followed a diagonal line through the cements, as shown in the following section:—



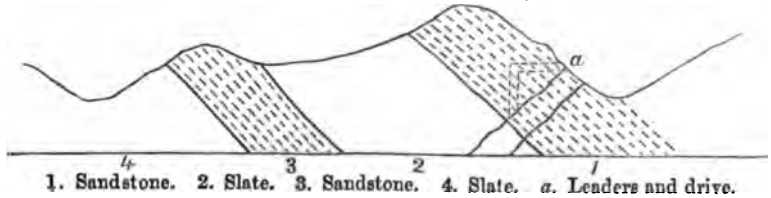
1. Sandstone above coal. 2. Coal. 3. Cements. 4. Sandstone breccias. 5. Slates. 6. Sandstones. *d*. Run of shode stones. *e*. Reef.

The reef was found at *e* in the old Golden Ridge Claim, at which point workings are now suspended. It occurred in a soft slate, striking E.–W., and underlying south at angles varying from nearly flat to 45°, and carried a little gold throughout, but with the appliances—a five-head battery and no berdans—was not always payable. The main reef consists of a fissure varying greatly in width, at times being as much as 20 feet between the walls. This fissure has, to a large extent, been filled with blocks of slate which have fallen in and been subsequently cemented by the auriferous quartz which traverses the reef in all directions. A hanging-wall leader has been struck at a certain distance in, which came in nearly vertical, then opened up to a chamber nearly 20 feet high, and subsequently dipped at an angle of 45°. This leader was followed when struck, and a great deal of gold taken out, but it eventually became poor, and no further work appears to have been done on it. The main reef has not been prospected at all in a systematic manner, for whenever a patch of gold was struck the whole number of men were put on to work it out, which, as might be supposed, has resulted in the closing of the old mine. No plan exists, so that it is impossible to form a very clear idea of what has been done. When the reef was abandoned the shareholders returned to the cements, but eventually became possessed of the Morning Star ground, which adjoins their original claim, and, taking advantage of three years' work which had been expended by the former company with no results, started to work the reef, and have had some very good gold from it. The slate in this claim is somewhat harder than in the old mine, but is still good

driving ground, although they are using dynamite here, whereas all the Golden Ridge Claim was worked with hammer and gad.

The reef at this point has an average dip of 1 in 6½, but varies a great deal, being sometimes nearly flat, and I am informed that the flatter parts have generally proved the richest, especially where the foot-wall is smooth and well defined. As in the other mine, the reef is sometimes very thick, but the original fissure has been filled in to a large extent by falls of slate, so that the quartz and gold traverse the reef as a series of cross-veins which come together in the thinner portions, and then, at times, are very rich. It occurs, I consider, under very favourable circumstances, since it crosses the country which is found stratified in alternate hard and soft bands, and will, I believe, prove a very valuable property; but there is every prospect, from the present style of working, of the Morning Star ground sharing the same fate as the Golden Ridge. The present works are all on the dip of the reef, which is opened by an irregular dip drive from a few feet to over 20 feet in width, as the reef has proved payable or not, and no prospecting tunnels have been put in along the strike of the reef, so that when the present shoot of gold is lost the work of prospecting will have to be undertaken. It is, I understand, proposed to erect another five head of stamps, but the money would be far better expended in thoroughly prospecting the mine, and in the erection of a berdan to treat the tailings, an assay of which shows that over 2oz. of gold per ton is at present being thrown away. Several other claims have been marked out adjoining or in the vicinity of the Golden Ridge, but at the date of my visit no work was being done on any of them.

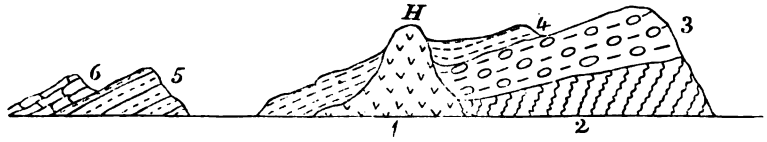
Shaw and Wilkie's Claim, from which some stone forwarded by Mr. A. Maginnity yielded 8 oz. 13 dwt. per ton, is situated about two miles further towards the Anatori River than the Golden Ridge, and between Maori and Tinnie's Gullies. They are working on two thin leaders from ½ inch to 4 inches in thickness, which traverse the hard siliceous sandstone previously mentioned, and dip N.E. at an angle of 30°. The sandstone has a S.W. dip at an angle of 50°, and is interbedded with thin bands of slate; while at a short distance off in a north-east direction a softer belt of country, which should prove more kindly for gold, comes in; it is very highly mineralized, that on the surface being quite rotten and completely honeycombed with the cavities left by the crystals of pyrites which have been decomposed and washed away. The following section shows how the leaders, &c., occur:—



1. Sandstone. 2. Slate. 3. Sandstone. 4. Slate. *a.* Leaders and drive.

The leaders are cropping out at *a* and have been traced for some distance along the strike. A drive has been entered at *a* for a few feet, and a shaft sunk at the end of it, intersecting the leaders again, and they were proposing when I was there to work back to the outcrop and take out the quartz, a proceeding which was hardly likely to prove remunerative, as they would have to pack the stone either to Friday Creek or else to the Golden Ridge, to get it crushed. The distance of the softer belt of country from the bottom of their shaft is, on their own computation, about 20 feet, and, as there is very little water, I have advised them to put in a dip drive on their reef until this be struck, when they will be able to form some opinion as to whether the reef is worth working. In the present class of country, and with the thickness of the leaders they are at present working on, I doubt very much if they could make it pay to take out the quartz, even if it all contained as much gold as that sent to Wellington, which is doubtful, to say the least of it.

Lower Greensand (*Lower Coal-Measures*).—These beds consist of conglomerates, breccias, and hard indurated sandstones, with which are interstratified beds of shale and several thin seams of good bituminous coal and fireclay. They occupy the tops of the ranges between Collingwood and West Wanganui Harbour, resting, at the Wallsend Colliery, on the upturned edges of the schists, at an altitude of 800 feet above the level of the sea, from which point they may be traced along the ranges through Plumbago Creek to Pakawau, where they are nearly at sea-level. In a south-west direction they may be followed to Otamataura Creek, and thence to the Ramparts, and they dip below the next series or upper coal-measures in a north-westerly direction.



Section on line D–D. 1. Granite. 2. Metamorphic schists. 3. Lower coal-measures. 4. Upper coal-measures. 5. Calcareous sandstone. 6. Limestone. *H.* House-roof Hill.

The coal is only being worked at the Wallsend Mine, where five distinct seams occur, none of which are over 2 feet in thickness, but in some cases two of these bands of coal are separated by a thin bed of fireclay, which Mr. Rees proposes to work for his cement process, in which case the coal will be got cheaper than hitherto.

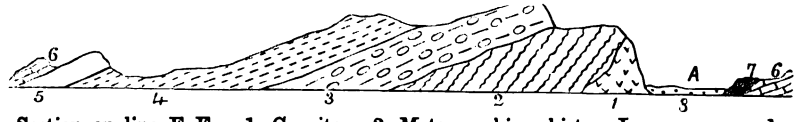
In Plumbago Creek the coal appears to have been altered by local conditions to a graphite, which is, however, of very inferior quality, being, so far as can be seen, so mixed with stone as to be of little or no value for economic purposes. It occurs as boulders in a drift, and also in a seam which is standing nearly vertical.

Many of the blocks of stone look very well on the surface, being coated all over with a thin layer of plumbago, but when broken into it is found to be nothing but a scale, the rest being stone with a very little plumbago through it: the same remarks apply to the graphite at Pakawau, but here the coal-measures have been crushed against a boss of granite, instead of the crystalline limestone as in Plumbago Creek.

Cretaceo-tertiary Series.—The lowest beds of this series are the sandstones, shales, and grits, with beds of brown coal, in which the West Wanganui Coal Mine is situated. They are striking about N. 60° E., and dipping N. 30° W. at low angles, and they cover a very considerable area, widening out in the West Wanganui district, so as to cover a belt of country about five miles in width, which may be traced from the north-east end of West Wanganui Harbour as far as the Paturau River, from which point they contract as we pass south. At the Golden Ridge there is a small extent of the coal, and several outcrops are found about there, while at Malone's Creek there is another outcrop which is on fire, this being what was reported some months ago as a new volcano. To the south of this again the coal-measures may be traced to the Anatori River, where they occupy but an inconsiderable surface area; while to the south of this, on the Pakihi ground, between the Anatori and Turimawiwi Rivers, they have a larger development again, stretching back on the hills to an altitude of about 1,200 feet, and from there they extend in the direction of Big River. An outcrop of coal 5 or 6 feet thick is reported at the Turimawiwi, but I did not see it, probably because it has been obscured by slips since it was first found. The West Wanganui coal is well known as a very superior household coal, and the company which is in course of formation to work it should have a successful future before them, since the coal-measures can be traced round the harbour with a very uniform dip until the Maori pa is reached, with the exception of one point, past the last bore-hole, where they are tilted at a high angle for a short distance. The boreholes are well placed for proving the coal area, and, as I am informed coal was got in each of these, it appears probable that the company has a mine which will yield a regular output for many years. The special advantage the mine possesses is the ready way in which the coal separates from the roof and floor, and also from the parting which occurs between the upper and lower seams, which will serve to build pack-walls with in the workings. In the bed of the Maungamaungaraku Creek there are numerous outcrops of thin seams of coal, but it is probable, as this creek crosses the strike of the strata at a very acute angle, that these are outcrops of only three or four seams which are exposed from time to time by the course of the river.

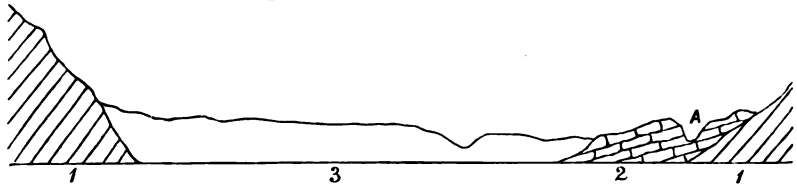
Overlying these coal-measures comes a belt of grey calcareous sandstones (which are well known as forming the Kaipuke Cliffs

between the Turimawiwi and Anatori Rivers), which have been placed as equivalents of the Ototara and Weka Pass stone; they are more or less marly near their base, and very concretionary in parts, and are identical in character with the calcareous sandstone of Silverstream, from which I made a large collection in 1881. They are overlaid by a limestone which is continuous along the coast from just north of Punipawa to the West Wanganui Heads, occupying the coast-line, and rising on to the hills to form the coast range. It seems probable that this calcareous series is unconformable to the coal, since on the eastern side of the Wakamarama Mountains it is resting hard on the slates and schists; but in the West Wanganui section no unconformity can be traced.



Section on line E–E. 1. Granite. 2. Metamorphic schists. Lower greensand: 3. Lower coal-measures. Cretaceo-Tertiary: 4. Upper coal-measures; 5. Calcareous sandstone; 6. Limestone. 7. Blue marls. 8. River-gravels.

Pliocene (*Blue Marls*).—The foregoing formations are overlaid unconformably by a series of blue clay-marls which occur up the Aorere Valley from its mouth, where they form the cliffs on the south-east side of the harbour, and stretch along the coast-line both towards Takaka and Pakawau and back to Brown's River, their surface exposure gradually becoming narrower the further we recede from the coast-line. Between the Kaituna River and the coast they have been cut through by the Aorere River in comparatively recent times, the Aorere having evidently taken its course to the mouth of the Parapara since these beds were deposited. There are very few fossils in these beds, which I was formerly inclined to consider as related to the calcareous series last described, but they contain *Cristellaria, Saxicava,* and a few minute forms. The following section illustrates their relations well:—

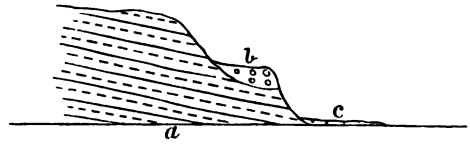


Section on line F–F. 1. Slates and sandstones. 2. Limestone. 3. Blue marls. A. Aorere River.

Pliocene (*Old River-gravels*).—As regards the old river-gravels I have nothing further to add since my report on Collingwood in 1881, except to state that my observations now bear out my remarks on them published in that report.

Recent and Pleistocene.—Down the West Coast raised beaches are of common occurrence as beds of shingle from 5 to 20 feet

above the level of the sea, and these are at places covered by considerable areas of blown sands. The shingle has no extent inland, for it is frequently seen as small patches, resting on the calcareous sandstones, in bays which exist now in precisely the same form as they did prior to the elevation of the land.



Section showing raised beaches. *a*. Calcareous sandstones. *b*. Raised beach *c*. Present beach.

The more recent gravels and blown sands do not call for any special remarks, and their boundaries will be found on the map.

ON A DEPOSIT OF MOA BONES NEAR MOTUNAU, NORTH CANTERBURY.

REPORT BY ALEXANDER MCKAY.

15th March, 1883.

DURING the winter of 1881 a flood occurred in North Canterbury which laid bare a deposit of moa bones near Motunau. This is exposed in the banks of a small creek which forms the boundary between the properties of Mr. Arkle and the Hon. William Robinson. Mr. Robinson having reported the discovery to Dr. Hector, I was sent to examine and collect from the deposit.

Where exposed the bones form a closely-compacted bed, varying from a few inches to 18 or 20 inches in thickness; and within a distance of 40 feet they occur in gravel, sandy clay, plastic clay, and peaty lignite, the progression as stated being from east to west, there being a slight dip of the bone-bed in that direction. In the banks of the creek the bone-bed is overlaid by a deposit of gravel, sand, clay, and loam, to a depth of 10 or 12 feet, and has at one time been covered to a much greater depth, as in the immediate vicinity there is evidence that the bones must since their deposition have been covered by at least some 50 or 60 feet of a deposit similar in character to that which at the present time is seen to overlie them. Mr. Arkle informed me that for many years past he had noticed bones in the bed of this creek, which he now recognizes to be moa bones; and to this gentleman is due the discovery of the bone-bed, which he observed immediately subsequent to the flood mentioned. Part of the deposit lying within his property, Mr. Arkle kindly gave me permission to make such

excavations as I should deem necessary, for which I take this opportunity of thanking him.

The thickest part of the deposit appearing to lie on Mr. Robinson's side of the creek, I opened a paddock on that side. In doing so 5 or 6 feet of sandy loam was first passed through, in the lower part of which stumps of trees were encountered of which no indications appeared at the surface. Below this for the next 2 to 3 feet a sandy bed with patches of gravel was encountered, after which a bed of variable composition (quickly changing from sand to plastic clay) overlaid the stratum in which the moa bones occur. The bone-bed over the area excavated varied from 1 foot to nearly 2 feet in thickness, and consisted of a closely-compacted layer of bones, the interspaces between which were filled by a soft tough clay. The whole rested on a bed of well-rounded gravel, the thickness of which could not, at this place, be ascertained. All the bones, as far as the bed was excavated, appeared to have been disarticulated before being finally deposited, as no two bones were found which lay in such a position as to warrant their reference to the same individual moa. Most of the tibial bones were not found lying in a horizontal position, but inclined at all angles, and so locked in the deposit one by the other, or by the other larger bones of the leg, that the extraction of one of them almost invariably involved the destruction of one or more lying contiguous to it.

Although at first sight the bones appeared as a confused mass, yet there proved to be some order in the mode of their occurrence. In the eastern end of the paddock most of the metatarsal bones were found. Tibiæ were most abundant in the middle part, and femora at the western end. Where the bed was thickest the pelvic bones formed its upper part, and were universally in a crushed and highly decomposed condition. Vertebræ, toe-bones, and occasionally bones of the head, were found from top to bottom of the bed. In the clay bed which at the western end of the paddock overlaid the bones, vertebræ and toe-bones were of frequent occurrence, and in this horizon was found a metatarsus with the toe-bones complete. The metatarsus was lying horizontally in the clay bed, while the toes were sunk in the clay in a vertical position.

In the comparatively small area of this paddock, which was less than 30 square feet, there must have been present skeletons or portions of skeletons of not less than thirty birds. To all appearance the deposit is a most extensive one, the thickest part of it extending north-east from the northern bank of the creek: how far it extends in this or in the opposite direction on the southern bank of the creek, indications at the surface afford no means of determining.

On the southern bank of the creek the bone-bed is not so thick, and, following the watercourse upwards, it passes into a bed

of peaty lignite without bones, but a few feet beyond this bones are present in the lignite where it crosses the water-channel and is exposed at the base of a low cliff bounding the upper end of a deep gulch, which is rapidly being cut back towards the source of the creek. Followed till disappearing under the northern bank, the bones in the lignite increase from an occasional one till they form a bed about 8 inches thick, the lignite increasing to about double that thickness, but being without bones in its upper part. In the peaty lignite the bones proved quite as much crushed as, and much more fragile than, where they were imbedded in the clay: in fact, the vertebræ and other bones of open texture were little more than discernible in the lignite, while the leg-bones were, though apparently in good condition, so brittle that scarcely any could be got out without breakage. As there appeared to be no difference in the species imbedded in the lignite and in the clay, I excavated but a small paddock in the lignite, and, getting nothing more than I had already obtained in a better condition from the first paddock, I did not think it necessary to continue the work of excavation.

All of the moa bones collected seem to be referable to not more than two species; and, of these, the bones of *Dinornis elephantopus* certainly constitute nine-tenths of the whole.

The remains of other birds were very rare in the bone-bed, belonging, with the exception of a few fragments, to *Harpagornis moorei*. All the bones of this species that were strong enough to resist the pressure of the overlying deposit are beautifully preserved. The only part which has suffered damage from this cause is the skull, which, occupying an interspace between two large moa bones, managed to escape total destruction. A curious feature in the mode of occurrence of these *Harpagornis* bones is that all those of the leg and wing were found with their greatest length vertical in the bone-bed. This was also noticeable in the case of most of the immature moa bones.

Finding that there was but small probability of finding the skeleton of an individual moa by itself, and equally little being the hope of securing the material to construct one, I had to be contented with making a selection of the larger leg-bones, and such vertebræ, ribs, and toe-bones as were met with during the progress of the excavation.

I have already mentioned that the bone-bed was covered to some depth by a deposit of gravel, clay, and loamy soil, and that it rested on a bed of well-worn gravel, the thickness of which could not be ascertained at the place where the bones were found.

From a little south of the Motunau River to Stonyhurst, a distance of seven miles, these gravels overlying Tertiary strata form between the coast range and the shore-line a table-land elevated 200 to 300 feet above the sea. On the seaward side this is bounded by a line of high cliffs washed by the tide at high water. Besides the Motunau River, there are three smaller streams which, rising

on the western, break through the eastern ridge of the coast range and flow across these flats in narrow channels, which are now so deeply cut that until an elevation of the coast-line takes place they have no power to cut them deeper. A number of smaller streams rising on the flats, or commencing from the slopes of the neighbouring ranges, have near the coast-line cut deep channels quite to the base of the sea-cliffs. The deep narrow gulches thus formed do not as yet extend across the whole breadth of the flats, but terminate abruptly in a cliff beyond which there is no defined watercourse, and as a rule no permanent stream. North of Boundary Creek, which reaches the sea three miles north of Motunau, the surface of the flats undulates in low rolling downs, and one or two isolated hills stand above the general level. Close past the southern side of one of these hills runs the little creek in the banks of which the moa bones are found. Just abreast of the little hill the creek breaks the surface of the flat and plunges into the deeper channel which it cuts through the gravels, and further down its course into the underlying Tertiary strata. Along this and other creeks numerous sections show that a heavy deposit of well-rounded gravel of uniform size overlies the Tertiary marine beds. The gravels are parted 20 or 30 feet from their base by sandy clays, which at many places contain trunks of trees, or pass into beds of impure peaty lignite. This is the horizon of the moa bones. Above this lies an indefinite thickness of gravel and silt, variable on account of having been unequally denuded in different localities.

Professor von Haast's researches at Glenmark appear to have led him to the conclusion that there the moa bones occurred in three different horizons. These in descending order are,—

1. The turbary deposits near Glenmark homestead, from which the great bulk of the collections in the Canterbury Museum were made:
2. The alluvial deposits of Glenmark Creek and the Omihi Valley:
3. Pleistocene deposits occurring in Glenmark Creek, one mile above the home station.

In trying to correlate the Motunau bone-bed with either of these, it is at once apparent that this can only be done with No. 2 or No. 3.

The character of the deposits forming No. 2 agrees well, both as regards the material and the sequence, with the Motunau beds; but the alluvial deposits of the Omihi Valley show not the least sign of having been denuded further than by the excavation of the present creek-beds, while the Motunau flats, especially towards the northern end, have been so far denuded that the surface forms low rolling downs, with here and there a low isolated hill, of which an example stands close to the locality where the bones are found.

It is true that at Motunau these gravels are isolated from the

fringe of gravels skirting the coast-line near the mouth of the Waipara, and also from an extensive development of gravels on both banks of the Hurunui, and near Gore Bay, Cheviot Hills. At Gore Bay these gravels are in their lower beds alternations of silt and angular gravels, in which large angular blocks are of frequent occurrence. The upper beds are well-rounded gravels, clay, and loam, as at Motunau, but here the total thickness is much greater, ranging from 300 to 500 feet.

Marine shells are found in the lower beds, while from about the middle of the beds I obtained broken moa bones and fragments of moa egg-shell. I have little doubt but that these gravels are the same as those in which the bones are found at Motunau. In the latter locality the presence of the lignite-bed may indicate an unconformity between the higher and lower parts of the gravel deposit. This may be so and yet the younger upper beds may be of greater age than the alluvial deposits of the Omihi Valley. The Motunau moa-bone beds would therefore belong to the older beds in Glenmark Creek already referred to. These Glenmark beds belong either to the gravels of the plain south of the Waipara, or to the Upper Miocene beds forming gravels extending south from the Weka Pass to Mount Grey Downs, and forming part of the hills between Brown's Bridge and the mouth of the Waipara River. I should say they belong to the younger beds, and, as in character they agree with the gravels of Gore Bay, Cheviot Hills, we might thus find a reason for correlating them with the Motunau moa-bone beds.

After making the collection of moa bones for which the trip to Motunau was in the first instance undertaken, a few days were spent collecting from the fossiliferous Tertiary and Cretaceo-tertiary strata of the vicinity; and on leaving Motunau I proceeded to Cheviot, and there made some examinations with a like object in view.

The principal collection of fossils from Motunau was made from the marly strata succeeding the Amuri limestone, from which were obtained several corals, apparently not previously found in New Zealand strata, and which are likely to prove characteristic of the horizon to which they belong.

From the beds immediately underlying the Amuri limestone (*Teredo* limestone) a single vertebra of *Mauisaurus haasti* was collected, which is of interest as showing that this species survived till the commencement of the deposition of the more calcareous rocks succeeding the saurian sands and concretionary greensands of the Amuri section.

No further saurian remains were discovered in the boulder sands of this neighbourhood, but the coal-beds in Happy Valley were traced south, and identified as belonging to the same horizon as the coal-seam in the upper part of Motunau Creek at the back of Cabbage-tree Flat, proving that in both localities the carbonaceous deposits are of the same age as the coal-seams in the

Malvern Hills and the Middle Waipara, and are not of the Tertiary age ascribed to the Motunau coal-seam by Professor Hutton.

An examination of the older rocks forming the divide between the Omihi and Greta Valleys to the west and the waters flowing east to the coast-line, though not resulting in the discovery of fossils whereby their age might be proved, yet led me to the conclusion that these are of Triassic age. They in every respect resemble the rocks of the Okoku Range, west of Mount Grey, which, by the presence in them of *Monotis salinaria*, are thus proved to belong to the Triassic period. The examination of these rocks west of Motunau showed that in places they contain lodes of hæmatite iron ore, which will yet prove of considerable value. One outcrop in the Happy Valley Run shows excellent ore of a thickness of 6 feet, shading off into inferior material. A sample of this, analysed in the Colonial Laboratory, yielded 97·40 per cent. of ferric oxide, and is superior to the ores worked at Collingwood, Nelson, and at the Thames, for the manufacture of iron paint.

At Cheviot I examined the section from the plains east of the coast range to Gore Bay, and more especially the greensands at the latter place for saurian remains. No important discovery however was made, for, though I carefully examined the locality where Dr. von Haast discovered the remains of *Mauisaurus*, not a trace of further remains was to be found.

On the western slopes of the coast range between Gore Bay and the mouth of the Waiau-ua River the saurian beds are developed resting on Triassic rocks, and here a few fragmentary specimens were obtained, showing the presence of *Leiodon* and *Mauisaurus*. The specimens were mostly single bones enclosed in hard concretionary boulders of glance sandstone.

A small collection was made from Tertiary rocks, showing that the Motunau beds here present stretch across the flats, and crop out from beneath the alluvia of the low grounds on the eastern slopes of the hills to the westward.

The ranges on the western part of Cheviot are in part Triassic, like the coast range, but younger rocks of Liassic or Oolitic age are largely developed. These latter contain traces of coal, as thin seams and pockets, and specimens of excellent quality derived from them are frequently picked up in the creek-beds. From what I saw of the rocks I do not think that workable coal-seams will be found, as the conditions appear to be similar to those prevailing at Catlin's River and along the east bank of the lower part of the Mataura, Southland, where, though indications of coal are abundant, no workable coal has yet been found. At the Cheviot Hills there is the further disadvantage that the coal-bearing beds are mostly inclined at high angles, and unless a seam of considerable thickness were discovered such as occur could not be worked.

ON THE ANTIMONY LODES OF THE CARRICK RANGES, VINCENT COUNTY, OTAGO.

REPORT BY ALEXANDER MCKAY.

6th April, 1882.

As directed in your memorandum of instructions of February last, I have examined the antimony lodes in the northern part of the Carrick Range, and have the honour to report as follows.

The lodes in question are situated about four miles west of the mining township of Bannockburn, at an elevation of 3,000 feet above sea-level, or about 2,000 feet above the nearest level land of the Bannockburn Valley. A good dray-road reaches within a mile and a quarter of the lodes, a pack-track thence leading to the point where the lodes are being opened out. In the immediate vicinity of Watson and Buchan's leasehold outcrops of antimony ore have been found over a distance of a mile in a north-and-south direction, and for an equal distance in an east-and-west direction. The main outcrops are situated on the south side of a high saddle which lies between the north-west sources of Pipeclay Gully Creek and Deep Gully, which is west of the saddle.

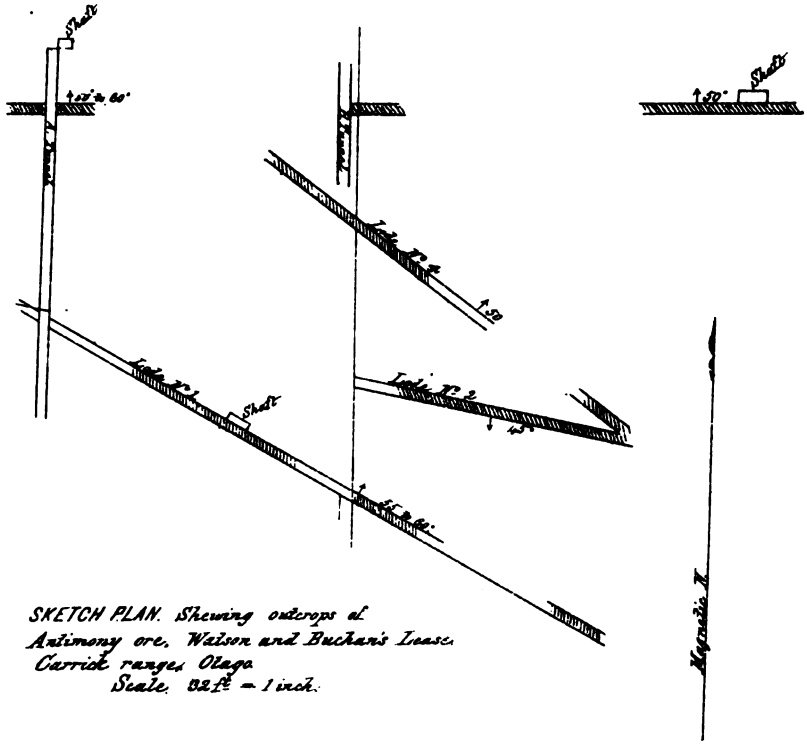
The rocks are grey, foliated, and highly-contorted mica-schists, dipping here to the S.W. and S., but at other places within the immediate district W., E., and N.E. This irregularity of dip also distinguishes the adjacent district to the south-east in which auriferous quartz reefs are found, and the observations made favour the opinion that a belt of disturbed country, characterized by an irregularity of dip, stretches from the Clutha Valley, near the Manuherikia junction, north-west across the northern portion of the Carrick Range to Doolan's Creek, near the upper end of the Kawarau Gorge. To the north-east of this line the lower contorted foliated schist is found towards the south-eastern end of the disturbed belt, while more to the north-west, in the Kawarau Gorge, the rocks are chloritic and soft blue schist, lying west of the great anticlinal axis. These underlying rocks are distinguished by the presence in them of calcite, which is rare in the rocks carrying the antimony, and appears to be absent also from the overlying rocks to the south and west. The overlying rocks are grey foliated mica-schists, in which quartz laminæ are less abundant, and in which quartz reefs but rarely occur.

When I visited the antimony deposits at the head of Pipeclay Gully prospecting was being vigorously prosecuted in Watson and Buchan's lease, and three strong leaders or lodes of antimony were exposed on the northern slope of the hill on the south side of the saddle already mentioned; and while I was there a fourth and perhaps the most important outcrop was discovered.

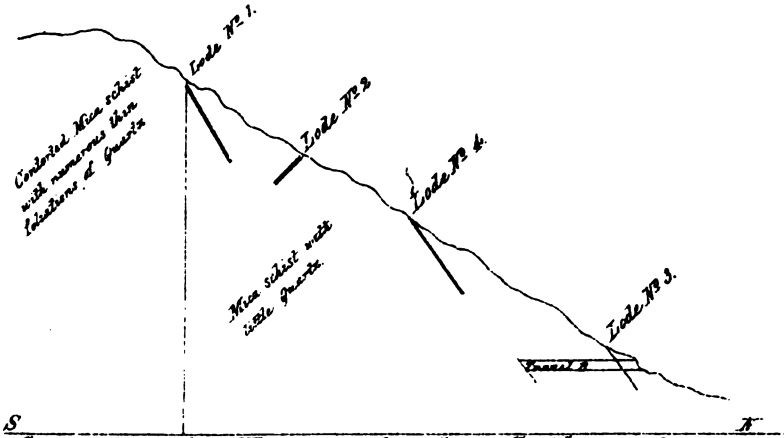
Three to four chains is the extreme limit to which any of these

Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.



SKETCH PLAN. Shewing outcrops of Antimony ore, Watson and Buchan's Lease. Carrick ranges, Otago. Scale. 82 ft = 1 inch.



Section N.S. across lodes, Watson and Buchans Leases. Carrick range, Otago.

lodes have been traced. Their outcrops are convergent to a point on the western side of the saddle at which as yet no prospecting work has been done. Subjoined is a sketch-plan showing the position of the lodes, and, where practicable, the work which has been done to develop them.

Lode No. 1, lying farthest to the south, and highest on the hill-slope, strikes about W.N.W., but dips to the north; the outcrop at the surface trending more to the N.W. Ore has been traced on this line for a distance of 3 to 4 chains. It appears to be patchy, but, the outcrop of the lode only being laid bare where ore has been found, there was thus no means of determining what proportion of the lode was ore-bearing. The principal openings on this line showed clean ore to a maximum thickness of 8 to 10 inches over a distance of 25 to 30 feet, but thinning out until lost in either direction at the outcrop, and behaving in like manner when followed to the dip, which is N. at an angle of 60°. An inclined shaft following the dip of the lode has been put down to prove this bunch of ore, but at some 16 to 20 feet from the surface it thinned out, and in the same working ore has not yet been found at lower levels.

At two or three points on the easterly extension of this line ore has been found cropping out at the surface, the bunches having an average thickness of 6 to 8 inches, but the extent of these has not yet been proved. Between a well-defined foot-wall and a somewhat irregular and ill-defined hanging-wall, the ore is contained in a mullocky matrix, and is generally very clean and free from quartz or other impurities. The foot-wall is hard, highly polished, and covered with striæ, showing the direction of the slide, which is coincident with the dip of the lode.

Lode No. 2 has not been traced for more than from 60 to 80 feet, but has been opened up for most of that distance. The strike of the lode is more westerly than No. 1, and, the dip being south at an angle of 45°, the two must intersect each other, and, within the area being prospected, at no great depth below the outcrop. The maximum thickness of ore in this lode was at one point about 13 inches, but usually where ore-bearing it is from 5 to 7 inches. At the eastern end of the line of outcrop, quartz replaces the slaty matrix seen further west, and the lode becomes very poor in antimony. In this lode the bunches of ore are in closer proximity to each other than they appear to be in Lode No. 1, and where the lode carries ore it may be said to have an average thickness of 5 or 6 inches. No systematic work of any kind has been done on this lode, and nothing further than extracting a few tons of ore from the richest part of the vein. As it converges at an angle of 30° towards the western extension of Lode No. 1, and dips to the south, intersection must take place, or a junction be made in the section-line shown on the plan, at no great depth; but no

attempt has yet been made to ascertain if the lodes become one at this point, or if the thickness of ore be greater.

Lode No. 4.—This is the third ore-band counting from south to north, but, being the latest discovered, has been called Lode No. 4. Its strike is N. 55° W., or nearly parallel to Lode No. 1. The dip is N.E. at an angle of 45° to 55°. Traced to the south-east, it crosses or makes junction with Lode No. 2 at the point where that lode has been farthest traced in that direction. The vein-stuff in this lode is much more quartzose than in any of the others, and, although in places the ore is not so rich, this is counterbalanced by its being less patchy. When I examined it about 80 feet of the outcrop had been laid bare, near the middle of which ore of good quality was showing of a width of 15 inches. This thickness, however, continued but for a short distance, the ore towards the north-west being about 6 inches thick, and towards the south-east so largely mixed with quartz that this was even poorer than the north-west end.

Lode No. 3.—This, the last and most northerly of the series, carries comparatively pure ore in a mullocky matrix. The lode strikes E.–W., and dips N. at an angle of 55°. In the softer ground where the lode is intersected by Tunnels A and B, the ore occurs as loose blocks, or aggregations of loose blocks, some of which weigh 200lb. to 400lb., and generally contain very clean ore. Shaft B, on the crest of the ridge towards the eastern end of the lode, as far as yet prospected shows at the surface a rib of about 6 inches of ore, which extends west a distance of some 20 feet. This shaft being sunk follows the ore-band, which thinning out disappeared at a depth of 8 to 10 feet; below 20 feet the foot-wall flattened until it dipped at little more than 20°, but shortly again resumed the angle observed at the surface, while ore of equal thickness to that seen at the surface appeared in contact with the hanging-wall, and, as far as worked upon, continued to improve in thickness up to the time of my leaving the district.

Pryde's Creek Lode.—About 800 yards in a south-east direction from the outcrops already described a lode occurs near the source of a branch of Pipeclay Gully Creek which has been named Pryde's Creek. This lode has been laid bare for about 40 feet along the strike, but only about 25 feet of its exposure can now be seen. Its bearing is S.S.E. to S., and the dip W. at an angle of 45°. The outcrop lies mainly in the bed of the creek (which is but a mere rill) which has been turned aside, and by open-cast workings the ore is taken out for 6 to 8 feet to the dip. As now exposed 6 or 7 inches of ore of good quality shows at the southern end of the cut, which increases at the northern end to 20 inches, and is said to have been 2 feet in thickness. At this point, however, the mass of the ore is pulverous and mixed with clay in which masses of harder ore are found.

At the present time it would be but mere guesswork to assert

what is likely to be the average yield of ore per fathom in these lodes, as scarcely in any case has the size of the bunches been proved, and of the proportion which the blank spaces bear to the ore-bearing portions next to nothing is known. The lodes are, however, sufficiently well defined to afford comparative assurance of their permanency, and, as far as has yet been shown, the bunches of ore are thickest in the lower levels. No. 3 Lode near the mouth of B Tunnel is double the thickness of the same lode on the crest of the adjoining ridge. The positions of the lodes are such that they present manifest advantages in the way of raising the ore cheaply; but their altitude, some 3,000 feet above sea-level, will prevent the transport of the ore to the smelting works (proposed to be erected on Bannockburn Flat) during a considerable part of the winter season.

Such objections as might naturally be raised to show that the lodes are too poor in ore to leave a margin of profit after paying for raising and transport to the Bluff or Dunedin, have been combated in a pamphlet entitled "The Minerals of Otago," by W. R. Buchan, who states that carriage from the Carrick Range to Port Chalmers will not cost more than £3 per ton, and, in speaking of his recent trip to Australia, adds that "One of the lodes examined by the writer [Mr. Buchan] in Victoria was in no place more than 8 inches thick, and in many places not more than 2 inches, and for hundreds of feet in some of the levels showed no ore at all. . . . An average of 4 inches under favourable circumstances is a good paying lode."

I have already said that, occurring as the ore does in patches with blanks of unknown extent between, it is not safe to estimate what the average thickness of the Carrick Range lodes may be; but I think it likely that an average of 4 inches will be reached, and as far as seen the lode in Pryde's Creek should yield considerably more than the amount stipulated for by Mr. Buchan.

ON ANTIMONY LODE AND QUARTZ REEFS AT LANGDON'S HILL, GREY COUNTY.

Report by Alexander McKay.

Wellington, 28th August, 1882.

In accordance with instructions to that effect I examined the antimony lode at Langdon's Hill on the 2nd of May last, and respecting this and other leases being prospected there I have the honour to report as below.

Of the seventeen claims taken up at Langdon's only three were being prospected when I visited the place. Work on the antimony lode had been stopped for some time, pending the results expected from ten tons of ore shipped to England. Langdon's Reef, 400 feet

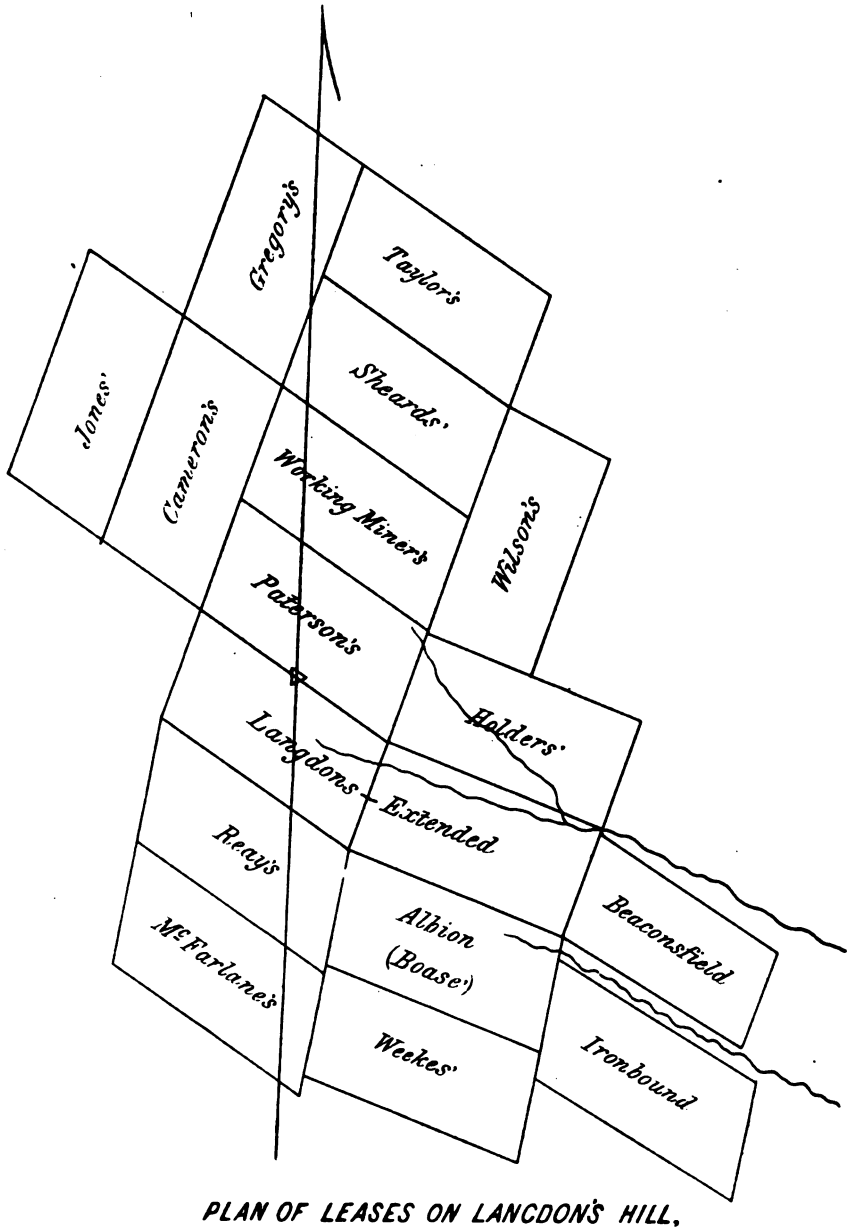
lower on the side of the hill, the Albion (Boase's), and the Working Miners' were the only claims on which work was being done.

Langdon's Extended: Antimony Lode.—There is little to be seen of this at the present time. The 9-feet lode described in the Geological Reports, 1878–79, has, across the face of the slip, been worked till it showed a thickness much short of 9 feet—in fact, from what I could learn seems to have pretty nearly nipped out. As, however, no attempt has been made to keep open the excavation, this has been filled and wholly obliterated by moving material from the upper part of the slip. Ore still shows in the face of the low cliff on the left hand looking west. At its greatest its thickness here is less than 3 feet, and followed to the dip it rapidly becomes less. An inclined shaft has been sunk following the ore at this point, showing its dip to be less than 40° for 10 or 12 feet, when it suddenly acquires a high angle of dip, but does not improve in thickness of ore as it is followed further. A tunnel has been put in from the south along the strike of the lode so as to cut the bottom of the inclined shaft, but in this also there was no improvement in the thickness of the lode. On the south side of the slip, a little below the level of the antimony outcrop, a tunnel was driven some distance north-west and then west, to cut the lode, but failed to do so. On the left-hand side of the slip the lode, where still seen, strikes nearly E.–W., and dips S. 40° to 60°. Traced across the slip the strike is N.W., and the dip to the S.W. A few feet from the antimony lode and on the west side of it an irregular reef of white quartz is traceable up the slip for some distance, but not eastward over the cliff beneath which the inclined shaft has been put down.

The rocks adjoining the antimony lode are on the hanging-wall side pyritous sandstones, into which thin veins of antimony penetrate for a few feet from the main body of ore. On the foot-wall side the rock is a blue silky slate, having a peculiar knotty structure, which when the slate is split gives it the appearance of a garnetiferous schist.

Langdon's Reef.—This reef, 400 feet below the antimony outcrop, is being prospected by a new tunnel driven a short distance west of the old one, which is not now available. Quartz had just been touched in the end of the drive when I saw it. Samples of the quartz taken from this lode analysed in the Colonial Laboratory yielded at the rate of 19 dwt. 12 gr. per ton. As far as could be made out, the reef was striking E.–W., and dipping S. at an angle of 80°. The rocks on the hanging- and foot-wall sides are the same as those encasing the antimony lode. Their strike here is N. 50° W., the dip being S.W. at an angle of 60°.

Albion (Boase's) Mine.—In this a new tunnel is being driven to cut the reef at a lower level, but when I was there had not got far enough to intersect the reef. Good stone is said to have been got at the bottom of the shaft in the old drive, but from the amount



PLAN OF LEASES ON LANCDON'S HILL,

GREYMOUTH.

Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.

of water making in the mine it was difficult to work this. It is to catch the reef at about the level of the bottom of the shaft that the new tunnel is being put in.

Working Miners'.—This claim lies to the north-east of the antimony outcrop on Langdon's Extended, and nearly at the same level. No distinct indications of a reef are visible, but a drive is being driven west in the hope of cutting a line of fault with a mullock band in the parting, near which it is hoped quartz may be found. A reef crops to the surface in Wilson's Lease, adjoining the Working Miners' on its south-east corner. The strike of this brings it within the Working Miners' Lease, but in such position that the present tunnel might be driven to the further end of the lease without touching it.

Wilson's Lease.—A reef of quartz 2 feet thick crops to the surface on this lease, crossing in a N.W.–S.E. direction the south-west corner of the lease. It dips N.E. at an angle of 30°. It has not been traced to the north-west into the Working Miners' Lease, but there is little doubt of its being continued in this direction for some considerable distance. For some 40 or 50 feet, the distance to which I traced this reef along its outcrop, it maintains an equal thickness, and is uniformly a white quartz when broken into, somewhat rusty brown where exposed to the weather, though showing very little pyrites. To the south-east the reef is traceable round the spur of the hill within Holder's Lease for a considerable distance. In this direction I did not follow it, but was so informed by Mr. R. Wilson, of Greymouth, who accompanied me to Langdon's Hill. A sample of the stone taken from the reef outcrop on Wilson's Lease, on being analysed in the Laboratory at Wellington, yielded gold at the rate of 3 dwt. 6 gr. a ton.

ON THE ALBION GOLD-MINING COMPANY, HUTT COUNTY.

REPORT BY ALEXANDER McKAY.

DR. HECTOR TO THE SECRETARY, ALBION COMPANY.

26th June, 1882.

I HAVE the honour to forward a copy of a report which Mr. McKay has made to me on the subject of the Albion Mine at Terawhiti. Further information will be supplied shortly, as soon as assays are completed.

Meanwhile I may state,—

1. That about 5,000 tons is a moderate estimate of the quantity of quartz actually proved to exist in the lode so far as opened out:

2. That the lode is remarkably steady, although it lies in the

bedding of the strata, and has no well-defined foot- or hanging-wall:

3. That the reef is flattening to the dip, but that a sudden change in this respect may be expected, so that the dip may become nearly vertical, or even reversed to eastward:

4. That the appearance of the quartz from the deepest levels is the same as that at the surface outcrop:

5. The work done appears to have been well directed and to the purpose, and the result of the exploration is as satisfactory as could have reasonably been expected.

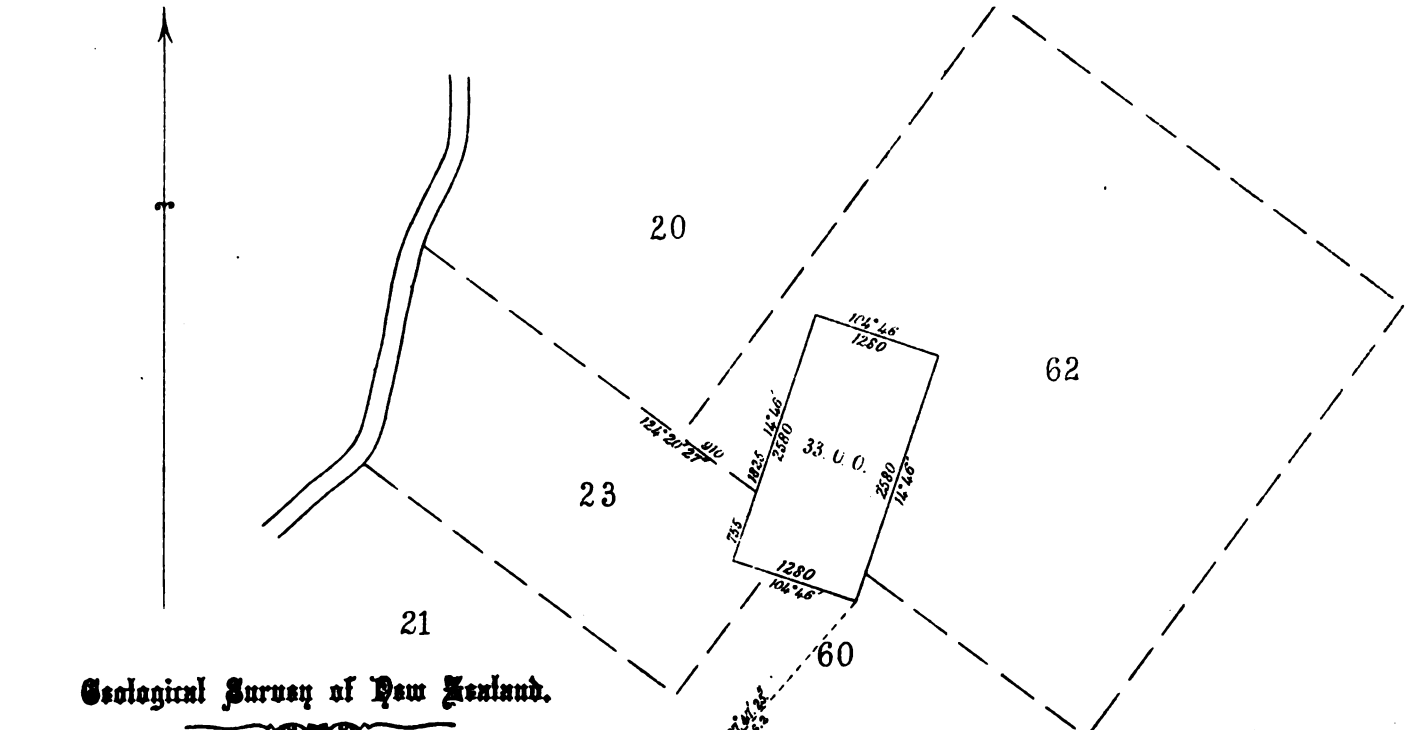
REPORT.

26th June, 1882.

I HAVE the honour to report that on Friday and Saturday last I visited the Terawhiti District, and examined the underground workings on the Albion and Merope and the Golden Crown gold-mining leases, and also made some further notes on the stratigraphical disposition of the rocks in the vicinity of these mines.

Albion Claim.—As most of the works done on this property have been executed since you visited the reef immediately subsequent to its discovery, I may here take the opportunity of giving a description of the work which has been effected in the way of prospecting the reef, and in making preparations for the extraction of stone.

After the sinking of a few shallow pits immediately contiguous to the first-discovered outcrop of the reef, the sinking of what is now the main shaft was commenced. This is situated about 35 feet south-west of the originally discovered outcrop, and at an elevation of some 15 feet above it. In sinking the shaft, the reef was cut 3 feet thick at 50 feet from the surface, showing that between its intersection of the shaft and its outcrop at the surface the angle of dip of the reef must be between these two points not less than 40°. After sinking to a depth of 80 feet, a level was driven west, which cut the reef at a distance of 70 feet from the shaft. On the reef being cut in this level, it was driven on both to the north and south. To the northward the works have fallen in, and cannot now be examined; to the southward they are also in a very ruinous and highly dangerous state. Where cross-cut the reef is at this level about 2 feet 6 inches thick, and to the southward shows continuously along the drive for about 30 or 40 feet. At the furthest point reached the reef is said to be 3 feet thick, and to carry good stone, estimated to yield 4 oz. of gold to the ton. At this point, however, nothing could be seen of the reef, as so much had the sides and roof fallen in that the drive itself is obliterated. The 70 feet driven from the main shaft to intersect the lode at this level (80 feet) shows that the lode has here a dip of about 30°. The shaft has now been sunk to a depth of 123 feet, at which level the lower tunnel has been driven, cutting the bottom of the



Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.

PLAN OF

ALBION COMPANYS CLAIM

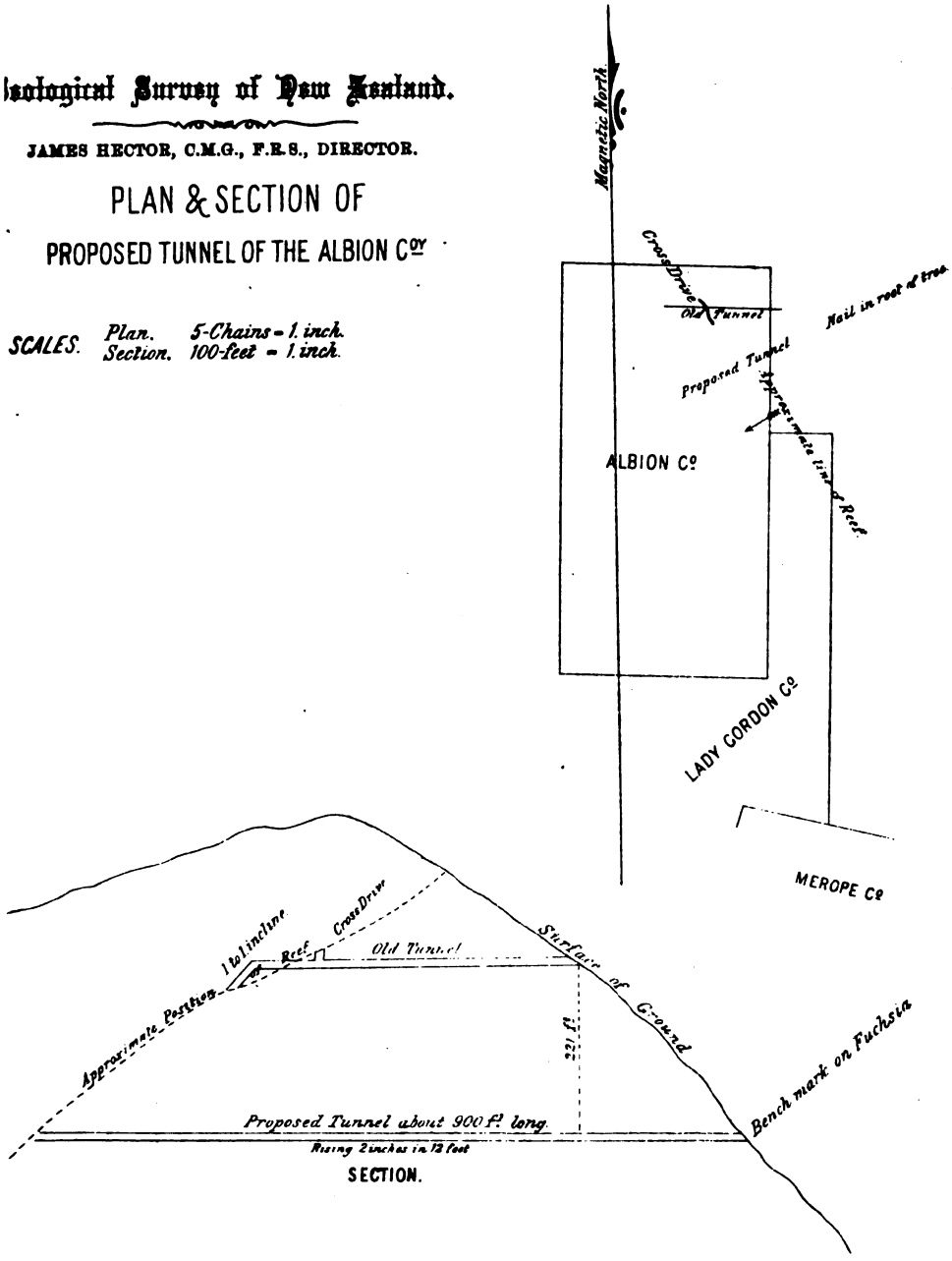
(Supplied from Co^y^s Office.)

Geological Survey of New Zealand.

JAMES HECTOR, C.M.G., F.R.S., DIRECTOR.

PLAN & SECTION OF PROPOSED TUNNEL OF THE ALBION Coy

SCALES. Plan. 5-Chains = 1. inch.
Section. 100-feet = 1. inch.



shaft and intersecting the lode at a distance west of the shaft 170 feet, showing the dip of the reef to be the same as in the upper level. The total length of the lower tunnel is 350 feet, and it is carried 50 feet beyond the point where it intersects the quartz reef. Where cut in this level the reef has been followed both to the north and to the south. To the north, as in the upper level, the drive is blocked up by material fallen from the roof, and in this direction cannot be followed. To the south the drive can be followed to its termination. The state of these drives prevents the thickness of the lode being readily ascertained, but it appears to be but seldom completely nipped out for any distance, and where it makes it may be averaged as being at least 2 feet in thickness.

The main tunnel being at this level driven 50 feet beyond the intersection of the reef, an inclined shaft was here put down, which proved the reef to have, at the bottom of this, a thickness of 5 feet, and to be of a more solid description than that found at higher levels. This is now full of water, and could not be examined, and none of the quartz from it was shown to me.

The strata, as seen in the different workings, have the same strike and dip as the reef, viz., strike N.N.W., dip W.S.W. at an angle of 30°.

The reef itself is well defined, and even when it nips out there should be little difficulty in finding it again, as its course is regular, and the usual indication of a pug between the walls seldom absent. I believe the lode will carry an average of 2 feet of stone, and the ground is easily worked, but will require close timbering to keep the works in good condition; and in this connection must be considered the low dip of the reef, requiring even a greater amount of timber. Before erecting crushing machinery it might be well to consider the suitability of the battery site which has been selected. Not that this is in the wrong place, provided the mine is worked from the eastern side as proposed. But if it can be shown that the mine could be opened at less cost and to better advantage at a point near the north-western corner of the lease, then it might be advisable to select another and more convenient battery site. The present tunnel cuts the reef 108 feet below the level of the outcrop, and, estimating the reef at 2 feet thick, the levels driven on the lode have proved the presence of some 5,000 tons of quartz. On the reef being exhausted to this level a tunnel at a yet lower level will have to be driven, which it is intended should be at 200 feet below the level of the present tunnel. This lower tunnel would require to be driven nearly 1,000 feet before it would cut the lode. The elevation of this proposed lower tunnel would still be from 400 to 500 feet above the battery site, and to reach the main entrance all timber, &c., required would have to be conveyed up the steep slope of the hill, at no small cost. The lower tunnel would not prove the quartz in the western portion of the lease, and if worked from this side a yet lower and propor-

tionately longer tunnel would eventually require to be driven. Practically this would be driving right across the lease, and then working back on the quartz overhead. Under these circumstances it is manifest that, if at the same level the quartz could be reached near the north-west corner of the lease, what would otherwise prove dead work in the lower tunnel might be expended in driving on the lode itself. The strike and underlie of the reef are such that it crops out at continually lower levels as traced north-west towards the head of the gully which separates the Albion Range from that on the western side of which are situated the workings of the Golden Crown Mine.

From what observations I was enabled to make, it appeared that the reef in this direction has a course more to the north-west, and a higher dip, and this, as a consequence, in a south-west direction. It would, therefore, be well to trace the lode from the vicinity of the present shaft as far in this direction as possible, and I think that by so doing it will be shown that it comes to the surface at a level considerably below that of the present tunnel, and, if the strike be here as stated, can be without much trouble cut at a yet lower level. It may, however, be said that in this direction the thickness of the outcrops has not been proved, and it is therefore safer to work the mine from the eastern side, where something of it is already known. I think, however, that the time which may be available before the arrival of the crushing-plant might be spent in tracing the outcrop to the north-west, and, should it prove to be there at a lower level than that by which the mine is to be worked on the eastern side of the hill, it will be for the company to decide what steps it is best to take.

ON AN ANTIMONY LODE AT REEFTON, INANGAHUA COUNTY.

REPORT BY ALEXANDER MCKAY.

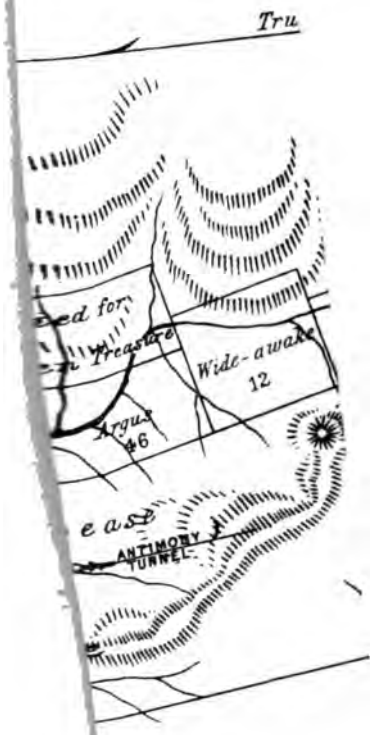
10th May, 1882.

IN compliance with your instructions to examine the antimony lode situated to the south of the left branch of the Inangahua River, within Bayfield and Anderson's Lease, I have the honour to report that I have made such examination, and to supply the following notes respecting the same.

The attached plan, for which I am indebted to the courtesy of Mr. Montgomery, District Surveyor, shows the position of the lease and the point at which the lode crops to the surface within it. From this it will be seen that the outcrop of the lode lies nearly south-south-west of Black's Point, at a distance of a mile and a quarter from the Inangahua River, and is most directly approached by following up Auld's Creek, which, coming from the south, joins

Geological S

JAMES HECT



the Inangahua opposite that township. The lode crops out on the southern bank of one of the western feeders of the above-mentioned stream, at an elevation of 1,400 feet above sea-level, or rather more than 800 feet above the valley of the Inangahua at Black's Point, the ridge of hills forming the watershed to the west and south attaining an elevation of from 1,600 to 1,800 feet. The whole neighbourhood is densely covered with bush, and carpeted with moss and other undergrowth-vegetation, which will account for the fact that the lode has not been traced (at the surface) north or south of the only outcrop known. Where seen the ore shows to a thickness of 18 inches, cased within a hanging-wall of sandstone and a foot-wall of crushed pale-green silky slates, presenting the characteristic appearances of the auriferous rocks between Reefton and Black's Point. The total width between the walls is not now easily ascertainable, a drive having been excavated in a southerly direction, cutting away the hanging-wall, while on the foot-wall side the loose slope deposit has not yet been cleared away. The block of ore is traceable a distance of 6 feet along the lode, and to an equal depth. A shallow pit, some 4 or 5 feet in depth, has been sunk alongside the ore on the foot-wall side. This is now partly refilled, and full of water, but I have been informed that ore was found on one side of this to the depth reached, but its thickness was not ascertained. The lode strikes S. 25° E., and dips E.N.E. at an angle of 75°. Along the hanging-wall side a drive has been put in to a distance of 150 feet, near the further end of which a shaft has been sunk to a depth of 36 feet, this cutting antimony ore at a depth of 20 feet below the level of the drive: here the ore is said to be much the same in character and thickness as it shows at the outcrop.

The works described were executed some years ago; they are now in such a condition that they cannot be examined, and for information respecting them I am indebted to Mr. D. P. Anderson, of Reefton.

This lode, originally discovered by Mr. Ranft some twelve years ago, was, under his management, partially explored, without giving results which at that time were considered satisfactory. Since then a lease of 240 acres has for mining purposes been granted to Bayfield, Anderson, and Co., who as yet have done nothing further towards the development of the mine, but who, I understand, intend to commence further prospecting works shortly. The work already done goes to show that the ore occurs in blocks, and that in a southerly direction there is at the level on which the tunnel has been driven a blank of at least 150 feet, but, on the other hand, it has been shown that along some portion of this distance ore occurs under-foot at no great distance below the level of the drive, and that, had this drive been put in either at a higher or a lower level, the results probably would have been different and more encouraging. I would not therefore discourage further work in

this direction as regards the continuance of the tunnel either at its present or at another level. So far as I am able to judge, the ore is likely to occur in blocks and bunches much in the fashion of the antimony lodes in the Carrick Ranges, Otago; and I believe that the outcrop seen at the surface is the southern end of such a block, which might be traced across the gully northward to the opposite spur.

With respect to the character of the ore, samples of which have already been analysed at the Colonial Laboratory, it is of a finely crystalline texture throughout, and a certain percentage of quartz is disseminated through it.

I saw no quartz adhering to the ore at or near the outcrop, but at the mouth of the mine were some pieces of quartz mixed with the sandstone of the hanging-wall, as blocks 6 inches square, containing ore more definitely crystallized than the mass of the lode, indicating that at places ribs of quartz occur along the course of the lode. I did not examine the course of the creek by which the mine must be connected (by a road leading along its banks) with Black's Point and Reefton, but understand that the 800 feet difference in elevation may be overcome by a road having a tolerably uniform grade, which, in the distance (a mile and a quarter), need at no point be excessive. Followed to the north the lode, if it preserves the strike observed at the outcrop, should cross the Inangahua at a point nearer Reefton than Black's Point. The strike observed would carry the lode across the river close to the Township of Reefton, and therefore the lode may possibly be picked up in Liverpool Davis's Gully, should it extend so far to the northward. Farther to the south and east, yet nearer the source of the main creek, are situated several gold-mining leases containing quartz reefs, some of which are known to contain gold. These appear to lie within an extension of the belt of soft country showing in the slip a little below Black's Point, which probably takes the valley of the larger creek by which the antimony lode is approached in its course. There is thus some prospect of other than antimony mines being worked in the same neighbourhood.

From the foregoing facts it will be apparent that I am not able to report as to the future prospects of this antimony mine. Practically I saw nothing but the outcrop, and that much in its original condition. That in itself is sufficient to warrant prospecting work being undertaken, and, with respect to the somewhat unsatisfactory results obtained in driving the tunnel, these are not more than might have been anticipated, considering the generally patchy character of antimony lodes.

ON THE GEOLOGY OF THE REEFTON DISTRICT, INANGAHUA COUNTY.

Report by Alexander McKay.

25th August, 1882.

In accordance with your instructions of the 8th of April last, I have the honour to report that I left Wellington for the west coast of the South Island on the 13th of that month. A delay occurred at Nelson by which I was detained at that place till Monday, the 17th, and did not reach Westport till the following day, the 18th of April.

My instructions directed me to proceed to Greymouth, and, on my way thence to Reefton, to examine the auriferous reefs and antimony lode at Langdon's Hill, near Brunnerton; but, as by steamer arrangements I should have been carried south to Hokitika, and thereby have risked further and more serious detention had I in this particular conformed to your orders, I deemed it best to leave the steamer at Westport, and proceed by the Buller route to Reefton. Unfortunately the mail-coach was delayed by the flooded state of the rivers, and did not leave Westport till the 21st of April, on which date I arrived at Reefton. Arrived at my destination, it rained almost continuously for the three following weeks, and during the whole of my stay at Reefton my efforts were most seriously impeded by the same cause.

Despite my being thus unable to carry out your instructions to their full extent, I persevered until in some measure was effected the chief purpose of my visit—namely, the making of a collection in duplicate of the rocks and minerals of the district, one set of which has been deposited at Reefton, as directed. The hindrances alluded to rendered the collections much short of what they might have been had the weather been other than extraordinarily bad, or had they been made at a more favourable season for reaching the higher and outlying portions of the district. Consequent upon these unfavourable circumstances I was unable to examine or collect specimens from the crystalline rocks of the Victoria and Brunner Mountains, and had to content myself with collections in representation of these made from their *débris* in the river-beds of the district: thus these rocks are very imperfectly illustrated.

Finding it impossible to do effective work in the higher and more rugged parts of the district, I left Reefton on the 31st of May, and proceeded to Greymouth, in accordance with further instructions which I had meanwhile received.

For aid and information accorded I have to acknowledge indebtedness to all, and would here mention the kindness of Mr. Montgomery, District Surveyor, in supplying me with maps and such information as might otherwise have been unattainable.

REPORT.

For guidance of my work in the Reefton District, your instructions were—

1. To examine the junction at the base of the auriferous series, with the view of determining the correctness of former observations bearing on the relation of this to the adjacent Devonian strata and other Palæozoic rocks of the district;

2. To ascertain the correctness of the reported discovery of stream-tin in the auriferous cements of Lankey's Gully, and to determine the relations of these cements to the lower beds of the coal-bearing series there and at Coal Creek;

3. To collect rock and mineral specimens illustrative of the various formations present in the district, and to deposit duplicates of these in the local museum being formed at Reefton; and

4. To make a general examination of the geology of the district.

In applying myself to each distinct subject of investigation the work of collecting specimens was simultaneously carried on.

As immediately prior to and during the time of this visit much interest was being manifested in and towards the development of the auriferous cements occupying the area between Coal Creek and the head of Lankey's Gully, in which the discovery of stream-tin had been made, my first work was directed to these, with the objects mentioned in your instructions.

Thus employed, it shortly became evident that the tin ore occurs but very sparingly, and is not likely to be found in paying quantities in the cements of this neighbourhood. Specimens of the cements showing tin can be obtained; but these are rather rare, and most of the samples which have been forwarded to the Colonial Laboratory and elsewhere have been got from the tail-races of the different sluicing claims which from time to time have been worked for gold in these cements. In the cement faces at Lankey's Gully, or in the materials broken therefrom, it is not at all times easy to detect gold, and the finding of a few scattered grains of tin sand is a yet more difficult undertaking; and for specimens showing one or other of these I had to be indebted to the miners who either then were, or had been, engaged in working the cements.

Almost necessarily, the relation of the auriferous cements to the coal-bearing series was investigated at this time; my conclusions respecting which will be given further on when treating of the formation to which these belong.

While engaged as above described I made the acquaintance of Mr. Alexander Ross, who for a considerable time had been engaged in working the auriferous cements at the head of Lankey's Gully, and in so doing had learned to distinguish the tin from other minerals found in the cements. Since then, and while on a prospecting tour amongst the ranges lying nearer the granite mountains, he hit upon a substance occurring in the wash of a creek,

which he satisfied himself was the same material that at Lankey's Gully passed for stream-tin. This he describes as occurring in considerably greater quantities than at Lankey's Gully, and after satisfying myself that the mineral described was not likely to have been concentrated and collected in the creek-bed by the denudation of a pre-existing area of cement in its vicinity, as no coal-rocks appear to occur in the neighbourhood, and the materials in the creek-bed are described as similar to the adjacent rocks *in situ*, I concluded that the supposed tin, whatever its true character, was directly derived from the neighbouring strata, and that here there was an opportunity of tracing the substance to its original source.

Mr. Ross volunteering to be my guide, some time was lost endeavouring to reach the locality where this supposed tin ore occurs, but heavy incessant rains, long continued, rendered the attempt unsafe as well as hopeless, and so reluctantly it had to be abandoned.

I next turned my attention to the other subjects of inquiry specified in your instructions, and at the same time continued making collections as opportunity offered.

Thus far the narrative form may have been best, but for the remainder of this report the facts observed can be more advantageously stated in a systematic description of the geology of the district, with such prefatory and concluding remarks as are fairly relevant to the subjects discussed.

Description of the District.

The Township of Reefton, situated at the south-eastern corner of the Inangahua Plain, lies about 30 miles inland from the west coast of the South Island, and is by road about 50 miles equidistant from the important coastal towns of Greymouth and Westport. Its position is such as must constitute it the commercial, as it is the natural, centre of an extensive, though as yet but partially developed, quartz-mining district lying between the middle parts of the Buller and Grey River valleys. The Inangahua Plain, having an average breadth of 6 to 8 miles, stretches north-north-east from the vicinity of Reefton a distance of 18 or 20 miles to the Buller River, which, in part, flows across its northern end. This level tract has an elevation of from 300 to 600 feet above sea-level. The breadth of the watershed of what is denominated the Inangahua Valley is much greater, some 20 to 25 miles. Bounded on two sides and the northern end by high rugged mountainous country, the Inangahua Valley is barred to the south and south-west by a less elevated hilly tract, across which communication is had with the Grey Valley and the seaboard in this direction.

Along the eastern side of the plain lies a broken mountainous country of moderate elevation, its greater heights seldom attaining more than 3,000 feet above the sea. At some distance beyond

this rises the rugged mountain chain which embraces the Victoria and Brunner Mountains, forming the eastern watershed of the Inangahua Valley.

To the west, after having passed the hilly and submountainous country which forms their eastern slopes, the watershed in this direction is formed by the Paparoa Range, attaining an elevation (in its higher peaks of some 6,000 feet) equal to that of the mountains forming the watershed on the east side of the valley. Towards the north the drainage from the mountains passes down the Blackwater. This and other smaller streams draining into the Buller River, both narrow the entire watershed and prevent the waters from the higher range reaching the Inangahua. The general slope, however, is towards the east, and, in spite of the direction of its drainage, this part may be looked upon as lying within the counter-lines of the Inangahua Valley.

To the northward, beyond the Buller River, the Inangahua Valley is bounded by a rugged and broken mountainous country, without definite continuous lines of elevation, which extends as far as or beyond the Mokihinui River, and limits the district in this direction.

To the south-west a strip of broken hilly country separates the Inangahua Plain from the more elevated flat lands within the watershed of the Little Grey. More to the south and east the country is excessively hilly, but can scarcely in comparison with its surroundings be considered mountainous. In a word, we have here a comparatively low and level track surrounded by slopes of higher elevation, and set in a framework of mountains.

Its rivers claim here a passing notice:

The Buller River, after in a deep gorge breaking through the high chain formed by the Victoria and Brunner Mountains, and its northern continuation the Lyell Mountains, crosses, from the east side, the northern end of the Inangahua Valley, and disappears among the mountains to the west, its narrow valley in that direction forming the lower gorge of the Buller River.

The Inangahua is a considerable stream, the main southern branch of which rises to the south-east, draining the southern end of the Victoria Mountains, and which, after a course of some length, breaks through and debouches from the inner eastern ranges at the Township of Reefton. Thence continuing its north-western course to the south-western corner of the plain, it is there joined by the Waituhi, or north branch of the Inangahua River, rising also in the Victoria Mountains, and which, with an equal volume and a course nearly parallel to the south branch, breaks through the inner ranges, and crosses the southern end of the plain to its junction with that branch. The united branches now form the Inangahua River, which flows north along the western side of the plain, and, receiving several considerable streams from the east and many smaller ones from the west, continues this course till it

falls into the Buller River at the north-western corner of the plain. From the east, Boatman's Creek, Larry's Creek, and Landing Creek are the most important. Of these, Larry's Creek is by far the largest, and might with propriety be regarded as the third main branch of the river. Boatman's Creek is much smaller, but will figure prominently in this report on account of the interesting geology of its valley, and the important mines situate therein. Murray's Creek, Lankey's Creek, Garvie's and Rainy Creeks, are mountain streams of small size falling into the southern branch above the Township of Reefton.

The district is generally closely and heavily timbered, the lower grounds and moderate heights being a mixture of birch and the ordinary pine-trees of the colony; at higher elevations birch, rata, and yellow-pine, with various trees of lesser size, are found. Open grass-land of some extent occurs on the Inangahua Plain, and the mountains in their higher parts are bare of forest vegetation.

Thus much of the immediate district. In conclusion I may here offer a few remarks on the surrounding region of which it forms a part. The ranges on the eastern side of the Inangahua Valley are the southern continuation of the eastern border of the mountainous country which forms the north-western corner of the South Island. As a chain of mountains this is deeply cut into where the Buller River breaks through it in the Lyell Gorge.

To the northward an unbroken chain extending forms the western watershed of the Buller Valley. This culminates and terminates in the massive bulk of Mount Owen, at the source of the river of that name. West of this mountain, the principal line of elevation is obliquely intersected in a south-west and north-east direction by the upper valley of the Wangapeka River, towards the source of which, and on its north-western side, this group of mountains is continued by the southern portion of the Mount Arthur Range. North of Mount Arthur the same line is continued unbroken to the sea at Separation Point.

Regarded as a continuous chain of mountains, this line of elevation exposes granitic rocks on one or other flank throughout its entire length. Its other rocks are various, Silurian, Devonian, Carboniferous, and even Cretaceous and Tertiary rocks being all present, and even the youngest of these at places are deeply involved structurally in these mountains.

A northern continuation of the Paparoa Range, though every here and there broken through by the gorges of the rivers which find their way from the interior mountainous track to the West Coast, is traceable alike by the general trend of the several blocks of mountains, and by the presence, this time most frequently on their western slopes, of a more or less continuous belt of granite. From the Buller River to the Karamea Bend mountainous country occupies the space between these two determinate lines of upheaval, connecting them between the points mentioned by a high,

excessively-rugged, and broken country, while the relative space further to the south is occupied by the Inangahua Valley and Plain.

Except in the occurrence of mountainous country in the Upper Buller Valley above the junction of the Mangles River, the district occupying the north-west corner of the Island is separated from the main chain of mountains forming the northern continuation of the Southern Alps by a breadth of comparatively low country, the rocks of which are of comparatively recent date. Their separation thus may be a fact of no great consequence in comparing the general geological structure of these distinct mountain regions, but, in so far as their mineral wealth has yet been tested, the western block of mountainous country has proved by far the richest. I have been thus led to sketch the main features of the region to the north and west, in order that any references which may be made to the physical features of the geology of these parts may be the more readily understood, believing that from Reefton to Collingwood will yet prove an extensive and connected reefing district.

PREVIOUS OBSERVERS AND THEIR WORK.

Of those writers whose work had a bearing on the geology of the district the number is not great. As far back as the year 1860, Professor von Haast, of the Canterbury College, Christchurch, conducted an exploring and prospecting expedition in the south-western portion of the Province of Nelson; at which time, after examining the Upper Buller Valley, he passed into that of the Inangahua River, and thence crossed the divide between that and the Grey Valley, which he followed to the sea. After various attempts made in a district which has since proved a great goldfield, his efforts to find the precious metal in paying quantities were not rewarded with success, and, in his report to the then Provincial Government, opinions in harmony with this experience were expressed. Subsequently, after the rush to the Grey Valley had taken place in 1865, prospecting for gold was pushed rapidly in all directions, and from Maori Creek, a tributary of the Little Grey, the first diggers reached the southern end of the Inangahua Valley, and established themselves in the neighbourhood of Reefton.

During the season of 1866–67 Dr. Hector explored the contiguous districts to the north and west of the Inangahua Valley, and at subsequent times paid several visits to the mining districts of the West Coast, but did not visit Reefton till December, 1873, on which occasion the minor reefing districts of Murray's Creek, Boatman's Creek, and Larry's Creek were examined; and, amongst other matters pertaining to the general structure of the district, its older fossiliferous rocks were determined as being of Devonian age, and their relation to the younger slates and sandstones carrying the gold reefs was determined.

The same year (1873) I was engaged to collect the rocks and fossils of the district, and to follow in some detail the more important sections, for the purpose of further verifying the relationships already established. While employed in this work large collections were made from the fossiliferous Devonian rocks of Lankey's Gully, and from strata of the same age on the banks of the Inangahua River. The Devonian rocks were traced south to the upper part of Rainy Creek, and northwards across the Waituhi or north branch of the Inangahua. On the same occasion the Waituhi was followed to the eastern border of the granite belt flanking and forming the lower slope of the Victoria Mountains, proving the presence of an area of the auriferous slates and sandstones lying to the eastward of the Devonian belt, and a development of the coal-bearing series and other younger rocks yet further to the east between that and the crystalline rocks of the higher mountains. Boatman's and Larry's Creek were partly explored in the direction of their sources, and the rocks on the west side of the valley were also partially explored and collected from.

The district was not again visited by any member of the geological staff till the end of 1876, when, in the course of a general examination of the West Coast, Mr. Cox, Assistant Geologist, and myself passed through the Reefton District, making our way from Rainy Creek past Merry-Jig to Maori Creek and Anthony's Flat. During this trip some attention was paid to the auriferous cement of Lankey's Gully and Coal Creek. Various mines were examined, and further collections made from the Devonian strata at Rainy Creek; but, in a hasty examination such as this was, the following-out of difficult details was not undertaken. Since then till the present occasion no further geological work has been done in the district.

General Geological Structure.

Granitic and metamorphic rocks constitute the Victoria and Brunner Mountains, forming the watershed between the Inangahua Valley and that of the Buller River above the Lyell Gorge. Similar rocks lie to the westward, and on that side of the valley form the higher part of the Paparoa Mountains, which, however, may be said to be beyond the limits of the Reefton District. On these, the lowest in position, and for the time being regarded as of the highest antiquity, rest Devonian and Carboniferous strata, tilted at high angles, and thrown into a series of anticlinal and synclinal folds, faulted, fissured, and filled with quartz reefs carrying gold and various metalliferous minerals. They have a linear extension in a north-and-south direction, and as a distinct range stretch along the east side of the Inangahua Plain from Larry's Creek to Reefton, south of which they are the basement rocks of a considerable extent of country in the direction of the Grey River. The same rocks bar the northern end of the

Inangahua Valley, and show in the bed of the Buller River for a short distance below the Inangahua junction. The country has not been sufficiently explored to prove their occurrence further to the south on this side of the valley, but, deeply buried beneath younger strata or showing at greater heights on the flanks of the granite range, it is highly probable that their presence will yet be demonstrated.

Next in age the rocks of the coal-bearing sequence are developed to a large extent on both sides, and are probably continuous across the immediate low grounds of the Inangahua Valley, since they dip towards its middle part, and crop out on either side, forming the inner middle slopes of the adjoining ranges. Coal rocks are found as outliers, sometimes of considerable extent, resting on the auriferous (Carboniferous) series and Devonian formation, and at places are deeply involved as structural rocks of the country.

Young Miocene or older Pliocene gravels form high terraces, the first lower hills on the east side of the valley, and also a stretch of hilly country barring its southern end. The remnants of wide-spread high-level gravels of younger date are met with generally over the hilly south-eastern part of the district; and a yet younger series is met with before reaching the recent river gravels and fluviatile deposits of the Inangahua Plain.

The following sketch shows roughly the geological structure east-and-west across the district, and this is shown in greater detail in No. 1 of the general sections accompanying this report. The map shows the area, at the surface, of the different formations:—

Geological structure, east to west, across the Inangahua Valley. (*a.*) Granite and other crystalline rocks. (*b.*) Devonian strata. (*c.*) Carboniferous strata, forming the auriferous series. (*d.*) Young Secondary and older Tertiary: Coal rocks. (*e.*) Miocene gravels, denuded into hilly country. (*f.*) Younger deposits—Pliocene to Recent.

In giving a more detailed account of the geology of the district I wish it to be understood that over much of the ground mapped the boundaries of the different formations have not been determined with accuracy, that being a labour requiring much time and under the circumstances wholly impossible. It has been necessary also to draw largely upon unverified former observations, so that at some places error may have crept in. It is yet hoped that these are few, and, where likely to occur, will be guarded against by stating the circumstances under which the observations were made. The formations occurring in the district are as follow:—

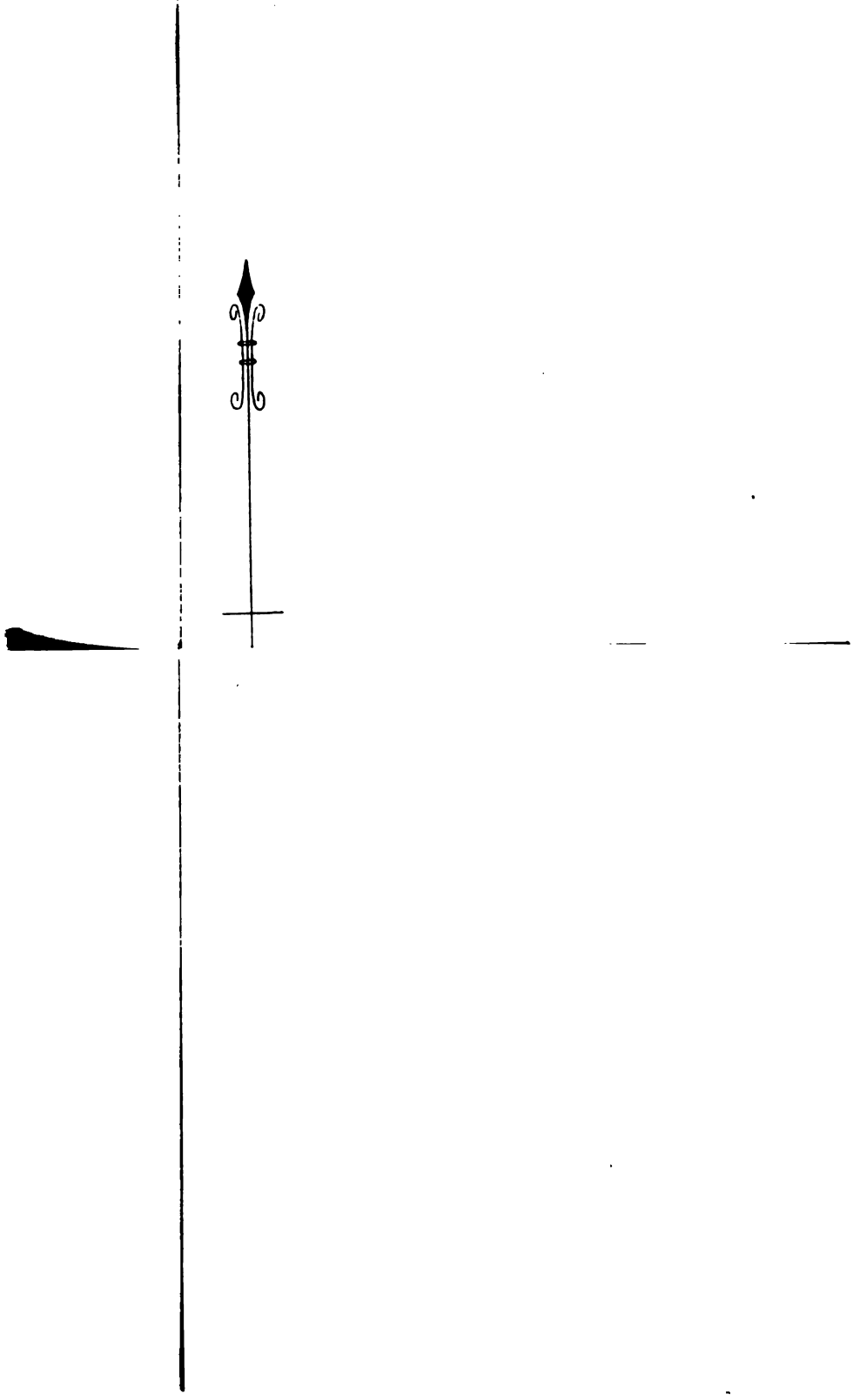


Table of Formations.	Formation.
1. Recent	I.
2. Pliocene gravels and drift	II.
3. Upper Miocene gravels	III.
4. Cretaceous and Cretaceo-tertiary, including—	
a. Cobden limestone	VI.
b. Gritty impure foraminiferous coral-rag	„
c. Dark marly strata, with concretions	„
d. Impure fossiliferous limestone	„
e. Brown fossiliferous sandstone	„
f. Grits, sandstones, and shales, with coal	VII.
g. Quartz-grits and auriferous cements	„
h. Great angular breccias	„
5. Carboniferous: The Maitai formation—The Reefton auriferous series	XII.
6. Lower Devonian: The Reefton series	XIII.
7. Granite and metamorphic rocks	XVI.

Granite and Metamorphic Rocks.

These were not examined on the present occasion, and this for reasons which have already been given: consequently for information respecting them I must be dependent on the collections made from their *débris* in the bed of the Inangahua River, and on notes made during a former visit. On that occasion (during January, 1874), I followed the Waituhi, or north branch of the Inangahua, upwards to the western boundary of the granitic belt, where the first of this class met with is a fine-grained syenitic rock, varying in colour from light- to dark-grey, which at this point is overlaid by the sandstones, &c., of the coal-bearing series. This syenitic rock forms rounded hummocky bosses on the north bank of the river. These peculiarities of outline, which are not common in the district, lead to the impression that here the rocks have been moulded by the action of glaciers; there being reason to think otherwise, it may be presumed that during the so-called Glacier Period in New Zealand (I shall presently have to speak of a much older) the valleys of the larger streams were filled with ice to a far greater distance, relatively, from their beginnings among the mountains than the point where this phenomenon was observed.

My object being effected, which was to reach, in this direction, the boundary of the coal formation, and otherwise to ascertain what rocks were in direct contact with the metamorphic series, I did not push my investigations further, nor seek to determine in what order the different varieties of granitic and schistose rock succeeded each other. Beyond the point reached the outer spurs of the higher range are bold and rugged, the river-bed gorgy and difficult to get along: and hence, with but a summer's day at my disposal, another reason why work was not carried further in this direction. However, judging from appearances in the river-bed, a light-coloured granitic rock must be strongly developed at a point beyond that reached.

In the valley of the south branch of the Inangahua work was

chiefly directed to the relations to each other of the Devonian formation and the auriferous series, a subject with reference to which I had special instructions, and, as it appeared probable that the junction of the granitic and metamorphic rocks with the auriferous series (it being probable that these, and not the Devonian rocks, here make junction with the granite) would prove to be obscured by deposits of the coal period or by the recent gravels of the river-bed, no attempt was made to reach the crystalline belt, trusting that elsewhere clearer sections would be found.

Further to the north, Boatman's Creek was explored from Capleston towards its sources, but not sufficiently far to reach the granite mountains. This creek, if it does actually rise in the higher mountains, brings but little *débris* therefrom into the channel of its middle and lower course.

At Larry's, the granite belt there crossing the creek is exposed a short distance above the Caledonian Mine, where the creek turning more to the south enters the mountains. At this point on the north side of the creek the mountain-slopes are precipitous, ending in sheer cliffs rising from the bed of the stream, which show the junction there made between the granite and the auriferous series, as this is developed at Larry's Creek. Close observation could not be made as to the character of the overlying rock, but near the junction on the south side of the creek the auriferous rocks have suffered a considerable degree of alteration, and are much more of a metamorphic character than are the gold-bearing rocks at Boatman's and at Reefton. Whether this is wholly due to their near contact with the granite, or to their belonging to a different and older formation, the observed facts are scarcely sufficient upon which to base a conclusion.

For three miles above the Caledonian Mine, commencing at the junction described, the creek-beds lie in a narrow gorge deeply cut into the granitic rock. At the lower end of this, where junction is made with the auriferous rocks, a quartz reef is seen cutting through both the granite and the overlying rock.

The gorge passed, the creek divides into two branches, the principal stream trending away to the north-east, the lesser in a south direction. But a short distance above its junction with the south branch the main stream issues from a deep impassable gorge, the mountains on either hand being as rugged and impracticable as the gorge itself appears to be.

At the upper end of the first gorge the granite is suddenly succeeded by what, nine years ago, I took to be slates and sandstones belonging to the auriferous series in a highly-altered condition. I now incline to pronounce these to be schistose rocks, and would be cautious in referring them to the auriferous series.

Close to the junction of the two branches of the creek a narrow exposure of granite appears between the slates, &c., mentioned, and other rocks of like character are exposed at and between the

forks of the creek. From my letters written at the time these examinations were made, it appears that comparatively little granite was found above this junction in either branch of the creek, the rocks noted being spoken of as highly-altered slates and sandstones, which, with perhaps too much confidence, were referred to as possible equivalents of the Devonian and auriferous formations. With greater experience in such matters, I am not sure but that the then reference was perfectly correct, yet at the same time I well know that satisfactory proofs thereof might not easily be obtained. At this distance of time I scarcely trust to recollection for their precise character, and, as circumstances compelled my hasty retreat from this inhospitable region, and that without bringing specimens of the rocks in question, my conclusions respecting them may require verification. For the present, it will be safest to regard them as schistose rocks of unknown age, as a very considerable development of such, occupying relatively the same position with respect to the granite belt, is to be seen in the gorge of the Buller River at and above the Lyell Township. Be it as it may (the character and age of these rocks), one fact is evident, namely, that towards the centre of this part of the mountain-chain granite is not the most abundant rock, as may be inferred from my notes. (*See* Geological Reports, 1873–74, p. 100.)

From the junction above the granite gorge of Larry's Creek, on following the south branch for half a mile this also divides, the smaller branch going to the south in the direction of the upper part of Boatman's Creek. This was followed for about two miles, when it turned to the south-west, and, becoming impassable, appeared to take its rise in the granite belt through which the lower gorge of the main creek is cut. From the first divide the branch going south has been worked for gold for some distance, and, from what I could learn, with fair results, but the inaccessibility of the position, and the price and difficulty of getting supplies, prevented its development and led to the abandonment of this locality.

The two main branches of the Inangahua River, and Larry's Creek as well, show almost exclusively a granity wash in their river-beds, and from this it would be scarcely inferred that nearer their sources in the mountains to the east rocks such as above described would be found as abundantly as they are. Whether the softer schistose rocks are as strongly developed towards the southern end of these ranges as they are in the central and northern part yet remains to be shown, as during my present visit no work was done in that direction.

When it is possible to make a thorough examination of the area covered by these rocks, it is likely to appear that, having a granite belt on the west side, the higher parts and eastern slopes of the Victoria and Brunner Mountains are mainly alternations of

gneissic and schistose rocks. This would be in accordance with the section from the northern end of the Inangahua Plain across the range to the Lyell, and thence up the Buller River to the Four-River Plain.

In discussing their age it will be readily admitted as probable that rocks of different ages may be represented. Mainly, I believe that the metamorphic rocks of the series are of Silurian age, although it is also more than possible that much younger rocks are present. On the valley side of the granite belt at Larry's Creek the rocks there carrying gold-bearing reefs form a northerly continuation of that range which at Boatman's and Reefton contains the quartz lodes.

From Boatman's the strike of the strata is north, the distance to Larry's not great, and, excepting the auriferous series, save the Lower Devonian rocks there are none in the district to which, as altered strata of the same age, the auriferous rocks at Larry's might be referred. That they are altered Devonian rocks is unlikely, the mass of that formation being cherts and limestones, which, however metamorphosed, could not assume the character of the rocks in question. The gneissic and schistose rock east of the granite belt may be said to be continuous north-west as far as Mount Owen, and there and north of that mountain the schistose rocks of the range are known to be of Silurian age. To this period, therefore, must for the present be referred rocks of like character in the Victoria Mountains, though it may be admitted that much younger strata have been altered and are here as metamorphic rocks as well.

Whatever their age it is important to note that these rocks extend north across the Buller Valley, and that in the softer schistose parts the auriferous lodes at the Lyell are being worked.

Did I credit what I have gathered from miners, prospectors, and others, I must conclude that this fact has not been fully realized by them, a widespread belief being entertained that no auriferous reefs will be found in these rocks. That such opinions, or the counter-attractions of more accessible country, have retarded the exploration of these rocks for mineral wealth is evident, and indicates the reason. This is unfortunate, as it must be evident to all who consider the matter, with these facts before them, that there can be no good reason why gold-bearing reefs should not occur, and the matter is the more inexplicable since most of the miners know that the rocks at the Lyell are of quite a different class from those in which the reefs are worked at Reefton and at Boatman's. The explanation seems to be this: that few have had the opportunity of seeing the rocks *in sitû*, or of comparing them with the like rocks at the Lyell, and that a wrong impression of them has sprung up through guessing at their real character from what may be seen in the river-beds of the district.

I reason less upon observed facts than such an important con-

clusion should be supported by, but may here state my conviction that in time the belt of auriferous country worked at the Lyell will be traced south across the Buller River, and thence along the ranges to the upper part of Larry's Creek, and eventually along the entire range to the southern sources of the Inangahua River. The late discovery of stream-tin in the cements at Lankey's Gully is likely to lead to prospecting in these rocks in the hope of finding tin lodes, and in this quest discoveries of quite a different nature are likely to be made.

It seems reasonable to suppose that much of the alluvial gold of the district has been derived from these rocks, as many creeks have been worked which have evidently been supplied with gold from them. The Lyell Creek is a prominent example of this, it being famed for the amount of coarse gold obtained from its bed. Unless explicable otherwise than as being derived from the rocks of the Reefton auriferous series, there are reasons to believe that the gold in the Lankey's Gully cements are referable to these rocks. There is thus every reason to suppose that prospecting in them will be rewarded with success, though it cannot be denied that the excessive ruggedness and general inaccessibility of the country will make this a difficult and most laborious undertaking.

Duplicates of most of the rock-specimens taken in illustration of this series have been deposited at Reefton. These, nineteen in number, were, as circumstances compelled, obtained from the Inangahua river-bed. They are nearly all granitoid rocks, and, as has been shown, do but imperfectly represent that part of the range whence they have been derived.

The following is a list of the rocks collected:—

1. *Felspar.* Locality: The Inangahua river-bed, near Reefton. This is a light-grey rock, externally on exposure weathering to a brownish-yellow. It is almost a pure mineral, crystallized, with the crystals so arranged as to exhibit a cone-in-cone structure. As a rock it does not appear to be abundant, only one specimen having been collected, of which a portion was left at Reefton.

2. *Syenite.* Locality: The river-bed near Reefton. In this specimen the dark-coloured mineral has a very distinct greenish tint. The rock is abundant in the gravel-beds of both branches of the Inangahua River.

3. *Syenite.* Locality: The river-bed near Reefton. A fine-grained rock, in which neither mineral forms distinct crystals; moderately abundant.

4. *Syenite.* Locality: The river-bed near Reefton. In grain similar to No. 3, but with a preponderance of quartz and felspar; colour, light-grey.

5. *Granite.* Locality: The river-bed near Reefton. In this specimen the quartz and felspar largely predominate, white mica being sparsely distributed in plates. The colour is white, and the specimen has scattered through it small crystals of highly translucent garnet.

6. *Mica-syenite.* Locality: The river-bed near Reefton. A coarse confused mixture, with much mica.

7. *Biotite* (?) *granite.* Locality: The river-bed near Reefton. A light-grey confused mixture, mainly felspar and mica.

8. *Biotite* (?) *granite.* Locality: The river-bed near Reefton. A light-grey rock, the quartz in which has a bluish tinge, and through which are scattered numerous small crystals of almost transparent garnet.

9. *Granite.* Locality: The river-bed near Reefton. A white rock with but a small quantity of mica scattered through the specimen in widely-separated plates.

10. *Syenite.* Locality: The river-bed near Reefton. A very fine-grained dark-grey rock, mainly a confused mixture of hornblende crystals in a grey matrix.

11. *Felspar crystals.* Locality: The river-bed near Reefton. This rock is composed of felspar and mica; in it are large crystals of felspar.

12. *Red biotite* (?). Locality: The river-bed near Crushington. In this specimen the felspar is red, the mica black: rather rare.

13. *Syenite.* Locality: The river-bed near Rainy Creek. Well-formed crystals of hornblende predominating.

14. *Granite.* Locality: The river-bed near Black's Point. Contains almost no mica.

15. *Crystalline schistose rock.* Locality: The river-bed near Reefton. Contains a good deal of mica; is a slaty variety of gneiss.

16. (Labelled No. 77.) *Syenite.* Locality: The river-bed near Crushington. A coarsely-crystallized rock.

17. (Labelled No. 26.) *Iron garnet.* Locality: The river-bed near Crushington. Rarely occurs in a white rock formed by quartz and felspar.

18. (Labelled No. 76.) *Quartzite.* Locality: The Cement Company's claim, Lankey's Gully. This is a fine-grained flinty rock, different specimens of which vary in colour from dark-grey to light-yellow. It is found as boulders and masses of considerable size, sometimes 3 to 4 feet in diameter. These are smooth, apparently waterworn, and do not look like the cherts of the adjoining Devonian formation: hence the reference of the specimen to the crystalline metamorphic series.

19. *Quartzite.* Locality: The river-bed near Crushington. This specimen contains crystals of iron- and copper-pyrites.

DEVONIAN FORMATION.

To Mr. Theodore Ranft, well known as an indefatigable prospector, must be accorded the credit of having first collected evidences of the existence of Devonian strata in the Reefton District. Nearly ten years ago, in November, 1872, he forwarded, through the local committee at Reefton, to the Exhibition held that year in

Christchurch, a number of fossil specimens obtained by him from Lankey's Gully, near Reefton. These coming under the notice of the Director of the New Zealand Geological Survey, Dr. Hector, led to the discovery and determination made the following year, of which some account has already been given.

The rocks of this formation, so far as yet known, do not cover a great extent of country; their exposure is never more than a mile in breadth. In a north-and-south direction they have been traced from the upper part of Rainy Creek across the south branch of the Inangahua River to the head of Lankey's Gully, where, on the height of land between there and Coal Creek, they are for a short distance obscured by the rocks of the coal-bearing series. From Coal Creek, a short distance above its junction at Cement Town, they extend along the eastern side of the upper part of Murray's Creek, in the direction of the saddle overlooking the north branch of the Inangahua River. Here and down the slope looking northward the ground has not been sufficiently explored; but, if not encroached upon, so as to be hidden, by the auriferous rocks adjacent to the east and west, the exposure of the Devonian formation is so narrowed as to be inconsiderable, besides being partly obscured by coal rocks in the upper part of Murray's Creek.

Directly opposite the Murray's Creek saddle, but on the north bank of the Waituhi (the northern branch of the Inangahua), the Devonian rocks are shown in a fine section displayed by a large slip on the southern end of the range striking thence north to Boatman's. How far in the direction of Boatman's Creek these rocks continue to be at the surface, I have not personally determined. Mr. Caples believes that they reach within a mile of the gorge of Boatman's Creek, and they are shown on the map as reaching thus far north. It may, however, be stated that no trace of them is met with in the bed of Boatman's Creek, nor in the smaller streams feeding it from the south.

Further to the north no Devonian rocks are known to occur in this range, or, indeed, anywhere within the Inangahua Valley. At the southern end of their exposure, near the old alluvial diggings in Rainy Creek, the Devonian strata disappear under coal-bearing rocks. Mr. Ross, however, informs me that in the creeks south of the coal area at Rainy Creek fossils in slate and other hard rocks are found in the wash of their beds, and that these fossils are the same as or like those found in Lankey's Gully. This, and further evidence which I have gleaned from others, added to the tendency of my own observations, supports the conclusion that to the south the Devonian rocks are not, as to the north, overlaid by, to finally disappear under, the sandstones and slates of the Reefton auriferous series, at least for some distance beyond the source of Rainy Creek.

At Rainy Creek these rocks have an exposure which is less than a quarter of a mile in breadth: followed to the north, this

increases till on the banks of the southern branch of the Inangahua it is somewhat better than half a mile. In Lankey's Gully, and along the upper part of Murray's Creek, the breadth is no greater; in many places it is less. The full width of the exposure is seen in the big slip on the north bank of the Waituhi, where it is yet short of a mile.

The rocks of this formation consist of cherts, limestones, and slates, succeeding each other in the order stated, the cherts being the lowest in position, and showing the greatest thickness of strata, unless rivalled by the limestones and slates on the north bank of the Waituhi.

The cherts are of various shades of grey, sometimes of a red colour: the highest bed overlying the lower limestone is white, is less of a quartzite than the lower beds, and at places might be mistaken for coal sandstone, especially where, as at the bridge crossing the Inangahua on the road to Rainy Creek, it is somewhat decomposed. The lower limestone is a black rock of a bituminous argillaceous character; the upper, massive or interstratified with slates, is light-grey, weathering externally to a brownish-red colour in places. The slates are siliceous, or more argillaceous as the higher beds are reached. Close to the lower limestone is a bituminous mudstone, which cannot fairly be called a slate. Slates, limestone, and cherts alike are fossiliferous.

The physical features formed by these rocks are bold and rugged, especially where the limestones and cherts are present. This is notably the case from the source of Lankey's Creek south to the right bank of the Inangahua River. In this part the cherts attain an elevation approaching 1,500 or 1,800 feet above the river valley, and, where broken through by the main branch of Lankey's Creek, present precipitous cliffs, which, in places, from a narrow scarcely passable ridge, sink sheer for several hundred feet, frowning over the narrow valley, and opposed to precipices rising on the other side of the gorge to yet greater heights. In the lesser, the right branch of the creek, the limestones also form high cliffs, between which the creek flows in a narrow, rugged gorge, disappearing, where the limestone ends, in a series of caves and underground channels, and makes its way through the spur intervening between this and the main branch, which it reaches some distance above the point where their beds at the surface make junction with each other.

In the upper part of Murray's Creek the cherts developed along its eastern side, and for some distance up Coal Creek, form bare surfaces of white or light-grey rock, sloping at high angles to the westward, which is the direction of the dip. At intervals these sloping faces of rock are broken by small streams coming from the east, thus forming somewhat rugged country. The slaty beds of this formation lying along the junction of the area of the auriferous series developed to the westward do not produce such bold

features as the cherts and limestones generally do, and their character of configuration is more akin to that of the auriferous series.

As these Devonian beds are flanked by auriferous rocks on either side of a comparatively narrow exposure, and as they nowhere have been observed resting on an underlying series, it is probable lower beds of the sequence have yet to be discovered. Discussing their age, both the rocks and the fossils will have to be compared with those of the Upper Silurian beds of the Baton River and Mount Arthur district, there being evidence that the latter might be expected to underlie, without showing a marked degree of unconformity between the two formations.

Before proceeding to a closer description of the beds I may here quote a passage bearing on these beds contained in a memorandum of instructions for my guidance, dated the 20th December, 1873, in which Dr. Hector says: "The rock with fossils *in situ* strikes across the district from S.E. to N.W., as shown in the plan [accompanying the memorandum], forming a very bold feature. One mile past the Wealth of Nations battery you will find a rocky point above where the track to Rainy Creek crosses the river, and opposite to a hut. This point consists of blue and grey limestones and red quartzites; dip, 50° to 70° to S.W. The upper bed is a blue madrepore limestone, and the fossils are in small beds with quartzites between. The limestone weathers red, and when in that condition fine casts [of fossils] can be got. . . Looking up the valley the same beds are sure to form the south-west flank of a high granite mountain, and in the opposite or north-west direction I traced them through the country to Murray's Creek. They seem to underlie and cut off the auriferous formation; but I wish you to look closely to this point. . . . They are probably Devonian, but this must be settled after you have made collections."

The result of my work on the occasion referred to was the bringing together a fine collection of fossils, and a good deal of evidence supporting the conclusions arrived at respecting the position of the beds, and their relations to the auriferous sandstones and slates in contact with them. During the progress of this work it became apparent that the boundary-line between the two limited the extension of the reefs in the direction of the underlying formation. It is true that the strike of the reefs is approximately parallel to the boundary-line on either side, and likewise true that at one or two places thin leaders of quartz have been found in the Devonian rocks; but it is still matter for surprise that nothing like a reef, and no auriferous stone, has been seen in or obtained from these rocks. The further work done since then has not negatived this conclusion, and, though reefs cannot reasonably be looked for either in the cherts or limestones, it is yet an enigma why there are none in the upper slates bordering on the auriferous series.

The details of the rock sequence are well seen in the section along the right bank of the Inangahua River, between the bridge-crossing on the road to Rainy Creek and its eastern boundary, less than half a mile higher up the river. The lowest beds observed are grey cherts, full of small leaders of quartz. The junction to the east is obscured, but this rock crops out close to the overlying sandstones and slates which form the eastern belt of auriferous country. Following the section into higher beds, that is, down the river, these lowest cherts are overlaid by a cherty calcareous slate, and this in turn by grey cherts containing obscure fossils, the latter rock being also intersected by small leaders of quartz. Dark-grey cherts succeed: these contain numerous obscure fossils resembling broken encrinite stems. Here for the first time strike and dip may be observed. The strike is N.–S., and the dip W. at an angle of 60°.

Red and flesh-coloured cherts next overlie, and are exposed between the first small creek to the eastward and the outstanding bluff terminating the bold spur running down to the river-bank at the bridge. These are succeeded by black mudstones, and a black or dark-blue limestone, forming the outstanding portion of the bluff. The limestone may be some 20 feet thick where the track along the river-bank is cut through it. On the south side of the river the thickness is greater, and followed to the north much less, this same bed being scarcely 2 feet thick in the upper part of Lankey's Gully. This limestone is rich in fossils, mostly brachiopods; but these do not easily free themselves from the matrix, and are much more intelligible when as casts their impressions are left in the partly-decomposed surface of the bed, or are obtained from loose blocks broken away from it.

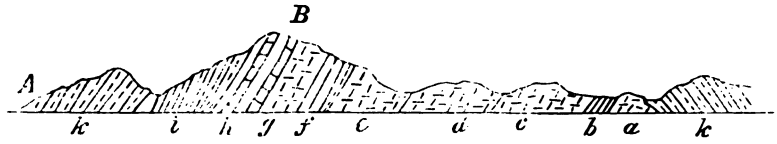
The next bed overlying is a white or light-grey chert, somewhat liable to lose its cementing medium, in which case it resembles and may be mistaken for the finer varieties of quartzose sandstone associated with the coal-beds. It is about 30 feet thick, and in this section without fossils.

Overlying this is a bed of limestone, and following upon that limestones and cherty calcareous slates alternate to a thickness of some 60 or 70 feet. This limestone is full of corals and shells, and is the madrepore limestone specially mentioned by Dr. Hector in the quotation above. (*See* also Geological Reports, 1873–74, p. 85.) The intercalated slaty beds are also fossiliferous, and when weathered yield fine specimens as casts.

This closes the section as far as at the present time it is clearly exposed, its direct line here terminating with a bed of limestone at the edge of the river-flat, but blue calcareous slates must here form, and elsewhere are known to form, yet higher beds. Such rocks are abundant along the foot of the range to the north-west in the direction of the lower part of Lankey's Creek, but so thickly timbered and encumbered with fallen rubbish and undergrowth

are the hill-slopes that the rocks are not now to be seen *in situ*. Many blocks and slabs of this rock have, however, been thrown to bank during the excavation of the Keep-It-Dark water-race, and from these numerous specimens were collected. These slates must have a thickness of not less than 200 feet, as their junction with the auriferous rocks next succeeding to the westward seemingly takes place in a gully five or six chains further down the river-bank.

The following sketch shows the sequence of the Devonian rocks as seen in this section :—



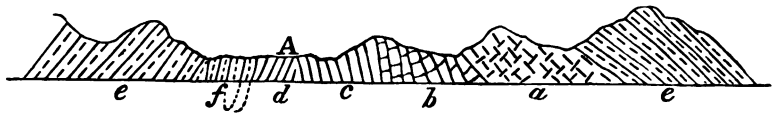
Section of Devonian strata, right bank of the Inangahua. *a*. Cherts with quartz veins. *b*. Cherty slates with obscure fossils. *c*. Grey chert with quartz veins and fossils. *d*. Dark-grey chert. *e*. Red and flesh-coloured cherts, with impure hæmatite. *f*. Black bituminous limestones and mudstones. *g*. White or grey chert—upper chert. *h*. Madrepore limestone, with slates between. *i*. Blue fossiliferous slates. *k*. Auriferous rocks. *A*. Lankey's Gully. *B*. Bridge crossing the Inangahua.

On the left bank of the river the limestones, especially the higher beds (*h*), are strongly developed, and protrude on the end of the spur opposite the bridge as large isolated blocks weathered red, in the manner already described (*see* description by Dr. Hector, *ante*, p. 107). These and the underlying cherts form a high spur ridge trending south to join the main divide between here and Rainy Creek. Parallel to this ridge and on its western side is a deep, narrow valley, scooped out of the overlying slates (*i*) and the rocks of the auriferous series (*k*), the junction of the two being apparently obscured by slope and creek deposits.

In the Rainy Creek section the breadth of exposure is less than in the section just described. This is due to a diminished thickness or less complete exposure of the cherts. These and the limestones dip to the east, and they in that direction are overlaid by the slates and sandstones of the auriferous series forming the hills on either side of the lower portion of the creek. As, though the dip is to the eastward, the cherts are still the rocks in contact with the auriferous series, and have the limestones to the west apparently dipping under them, and this is the reverse order of the sequence established elsewhere, it would seem that here there is an inversion of the Devonian beds; at least the cherts and limestones appear to be inverted, while the blue slates to the west of them are in a vertical position, or are dipping at high angles to the west. The creek cuts through the limestones in a narrow gorge, beyond which it exposes in its southern bank the black mudstones associated with the lower limestones, as already described.

Yet further up the creek are found the blue slates which are the highest rocks of the formation. At the junction of the limestones with the slaty beds to the west the strike is S. 10° E., and the dip east at an angle of 45°. In the black mudstones adjoining the strike is about the same—S. 5° E.—but the angle of dip has increased to 85°. In the blue slates the strike is 10° to the west of north, and the dip west at an angle of 80°.

From the occurrence of dicotyledonous leaves in the farthest west nearly vertical beds it is plain that coal rocks are deeply involved in this section in the position and manner shown below:—



Section of the Devonian rocks at Rainy Creek. *a*. Cherts, inverted. *b*. Limestone, inverted. *c*. Bituminous mudstones. *d*. Blue fossiliferous slates. *e*. Rocks of the auriferous series. *f*. Coal-bearing rocks. A. Old alluvial diggings.

In this section the arrangement of the Devonian rocks is somewhat different from that shown by Mr. Cox in his Report on the Westland District (Geological Reports, 1874–76, pp. 66, 67, sections). The difference, however, consists in the added interpretations shown to the westward, and in the omission of the deeply-involved coal rocks, and is therefore more apparent than real. My rendering of the section has for its basis the notes made during 1873–74 (*see* Geological Reports for that year, pp. 91 and 97), and the evidence bearing on the correct sequence collected during this visit. Between the beds *c* and *d* the dip evidences an anticlinal arrangement, but this is, I think, due to a line of fault cutting the beds obliquely, and bringing together beds separated elsewhere by the madrepore limestone and upper cherts. On the eastern side of the section the cherts and limestones must be inverted; otherwise only the upper cherts are seen.

From the right bank of the Inangahua River the Devonian beds strike north, and do not appear in either branch of Lankey's Creek till their junction has been some distance passed. In the left branch (the main stream) the beds cross nearer their junction than in the right, and do so nearly at right angles to the trend of that part of the creek. In the right branch the auriferous rocks continue to the limestone, and thus far are seen in both sides of the gully. Opposite the point where the old track to Cement Town leaves the creek the limestones are seen in such close vicinity to the auriferous rocks on the same spur that they must here make contact with each other.

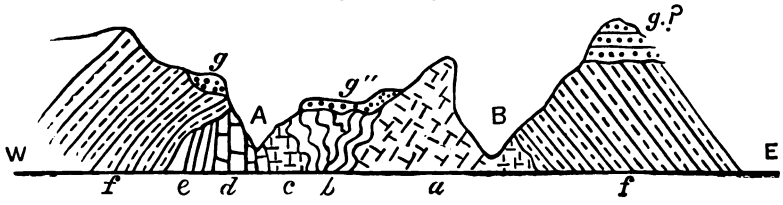
Closer to the limestone gorge a blue slate, with *Spirifer*, was observed during my first trip, apparently on the west side of the limestone. Yet higher up the creek the limestone, after forming a bold precipitous bluff, disappears beneath the auriferous rocks to the north-west; and still higher the actual junction

cannot without much trouble be discovered, but the rocks there adjoining those of the auriferous series must be, from the strike and what can be made out in the creek-bed, cherts and cherty slates; also blue slates with *Spirifer*, apparently a repetition of those met with farther down the creek. Nowhere do the lower cherts, described in the account given of the section on the banks of the Inangahua, appear on the west side of this branch of Lankey's Creek. The lower limestones and black bituminous mudstones pass through the Cement Company's Lease on the east side of the creek, and the bulk of the cherts lie between that and the left branch.

In the section across this part of the Devonian belt the rocks are much disturbed, highly contorted, and often locally inverted, but not to such a degree as to destroy the general sequence, which still has the great mass of the cherts on the eastern side and the limestones on the west, the general dip also being to the westward.

The lower cherts form high cliffs (already mentioned) overlooking the left branch of the creek. To the westward these are overlaid by more argillaceous beds, with black bituminous pyritous mudstones and bands of black limestone (representing the lower limestone of the Inangahua section), followed by grey cherts and blue slates with fossils: these beds often dip to the east, and thus show in an inverted position. These are succeeded to the west by the great madrepore limestone, present in and forming the narrower and deeper part of the gorge of the right branch of the creek. The madrepore limestone has blue *Spirifer* slates seemingly both above and below it, but this is in accordance with the clearer section on the banks of the Inangahua River. The average strike in Lankey's Gully is N.–S.; the dip is from 50° to vertical, and east or west according as the beds are inverted or otherwise.

The following sketch shows the position of the different members of this formation, on a line east-and-west across the Devonian belt near the head of Lankey's Gully:—



Section of Devonian rocks, Lankey's Gully. *a*. Lower cherts. *b*. Contorted cherty slates, black bituminous mudstones, and bands of black limestone. *c*. Cherts. *d*. Madrepore limestone. *e*. Blue slates (not now seen, as they are covered by *débris* from the sluicing claims). *f*. Sandstones and slates of the auriferous series. *g*. Coal, sandstone, and shales. *g''*. Auriferous cements. *g.?* Apparently horizontal strata on top of the mountain. A. Right branch of Lankey's Creek. B. Left branch of Lankey's Creek.

There being in the upper part of Lankey's Gully a tendency of the higher Devonian beds to pass under that part of the auriferous series which adjoins on the western side, either this or a thinning-out of the limestones has taken place between the point indicated and the junction of Coal Creek with Murray's Creek at Cement Town. The junction there takes place somewhat to the westward of the average line of strike observed further south, and only blue or black calcareous slates, overlying a considerable development of what appear to be the lower cherts, are seen in contact with the rocks of the auriferous series. Probably, therefore, the upper part of the Devonian sequence is here cut off, or overlaid by auriferous rocks. The presence near the western junction of red cherts, characteristic of the lower division of these rocks, renders this conclusion well nigh a certainty.

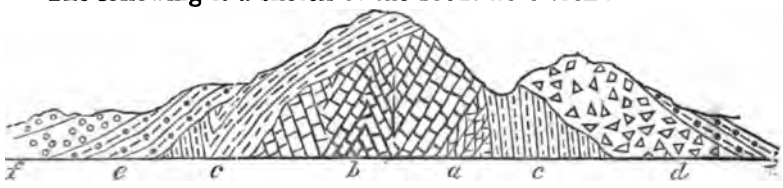
The strike of the slaty beds of Devonian age making junction with the auriferous series in Murray's Creek is N.–S., and the dip W. at an angle of 45°. There is some difference in the strike of the cherts nearer Coal Creek, that being N. 25° W., and the dip W.S.W. at the same angle. In the lower part of Coal Creek the cherts are obscured by the sandstones, &c., of the coal-bearing series; but further up the creek, where it leaves a deep gorge, the cherts are exposed, and continue visible in the bed of the creek till overlaid by the auriferous rocks east of the Devonian belt. Auriferous cements appear along the junction of these with the coal-beds here, as at Lankey's Gully.

Following Murray's Creek upwards from Cement Town, where observable the dip of the cherts is still to the westward. Cherts are seen on the west side of the creek near the site of the Westland Battery, and the adit level of the Golden Treasure Mine is partly in these rocks, or commences just at their junction with the auriferous series. Nearer the saddle at the head of the creek coal rocks overlie and obscure the junction. Limestones are said to occur on the northern slopes from Murray Creek saddle, and I have been shown specimens purporting to come from that locality, in which a little galena is present. Personally I do not know that the beds are continuous between the saddle at the head of Murray's Creek and the big slip on the north bank of the Waituhi, but with a greater or lesser breadth of exposure this is likely.

The section on the north bank of the Waituhi shows the Devonian formation, especially its calcareous members, to great advantage. In the big slip already mentioned, alternations of limestone with less calcareous beds repeat themselves, and form an anticline with a syncline on either side. The strata being sharply bent at the angles, the section on the hill-side presents the appearance of a W. On the up-river side cherts appear from beneath the limestone, and the section is flanked on either hand by auriferous rocks dipping away from the central Devonian beds. Grits, sandstones, and coal-seams flank the auriferous strata to the west; and

on the eastern side, after passing a narrow exposure of auriferous rocks, the section is obscure for some distance.

The following is a sketch of the rocks here seen :—



Section seen on right bank of the north branch of the Inangahua River. *a.* Cherts *b.* Limestones. *c.* Rocks of the auriferous series. *d.* Breccias under the coal *e.* Grits and sandstones belonging to the coal-bearing sequence. *f.* Upper Miocene gravels.

Being the oldest unaltered sedimentary rocks in the district, the question as to the relations of these Devonian strata is simply whether they, mutually with supposed Silurian rocks, have suffered from metamorphic action, and help to build up the crystalline masses of the Victoria and Brunner Mountains. In support of such a supposition but few facts have been ascertained. In his report on the Westland District, Mr. Cox in speaking of these beds says: "They are lying to the westward of the granite belt, but do not appear to abut against it, neither from their position do they show their relation to the metamorphic rocks. The metamorphic rocks there, and these older fossiliferous beds, form two distinct series, whose relative age cannot be made out by what has as yet been seen. They are, however, probably of greater age than the granitic belt before mentioned."

I believe that these beds are closely connected stratigraphically with the older palæozoic sequence seen further to the north in the Mount Arthur Range, where fossiliferous Silurian strata are traceable downwards into mica-schists, and where schistose structure is observable in beds even younger than the Reefton rocks; nor need I hesitate to adopt Mr. Cox's conclusion, that the intrusion of the granites and the implied alteration of the adjoining strata took place subsequent to the deposition of these Devonian rocks. With our very limited knowledge of the subject it may at the present time avail little to further discuss this question, although its importance and interest as a subject of inquiry cannot be denied. Of greater present interest are the relations of these Devonian beds to the auriferous sandstones and slates developed on either side of their exposure, which for the present need not be considered, as the subject will be more in place when the auriferous series has been described further on.

In the mineral character of its strata there is between these and the Silurian beds of the Baton River a resemblance: this is so marked in the occurrence of fossiliferous cherts and calcareous blue slates at the base of the one and the upper part of the other formation, that it naturally enough suggests itself that the two are

closely related in the same sequence. In support of this assumption, I may be allowed to quote a passage from a former report dealing with these rocks in the Wangapeka District: "Half-way between the points at which the Dart and Rolling Rivers respectively make junction with the Wangapeka, the chertose rocks already mentioned form high cliffs on the north-west side of the Wangapeka; and a little higher up the river, crossing over to the south-east side, they form the higher part of the range along the right bank of the Rolling River. Along the right bank of the Rolling River these cherts are seen to rest on the upturned edges of the bituminous schists forming the Mount Arthur series, the cherts here being associated with blue slates yielding the fossils of the Baton River series, but occupying the higher part of the range only. On the western bank of the Rolling River, the ranges between that and the Wangapeka consist mainly of a great thickness of unstratified chert rock, underlaid by blue slates." (*See* Geological Reports, 1878–79, p. 126, and sections accompanying: Sherry River to watershed of the Wangapeka and Karamea Rivers.)

None of these chertose rocks appear in the Baton River section, and the evidence is that there the fossiliferous beds occupy a lower horizon, while yet their fossils are in several instances identical with fossils found in the Reefton Devonian beds. Either, then, the Wangapeka cherts are identical with the similar rocks in the Reefton District, or the latter are the overlying beds succeeding them, as may be fairly inferred, without break or unconformity.

The fossil contents of the beds are a few Cephalopods, Gasteropods, and bivalve shells, associated with an abundance of Brachiopoda and Radiata. These are in process of examination, and for our present purpose may be spoken of without venturing specific designation.

Of the Brachiopods, a species of *Athyris* not met with at the Baton River is the most abundant. A broad-winged mucronate *Spirifer* is next in prominence, if not in abundance, this place being taken by the genus *Chonetes*, which in some of the beds forms layers of this shell only. Another species of *Spirifer* plentiful in the Reefton beds is common in the Silurian beds at the Baton River. That species most common at the Baton River —*Spirifera radiata*—does not occur at Reefton. *Rhynchonella* is poorly represented by some two or three species: one of these, resembling *R. wilsoni*, is plentiful in the Baton River beds. *Orthis* and *Strophomena* are genera that are fairly represented, and most of the species are the same as those found in the Upper Silurian beds at the Baton.

Of bivalves belonging to the class Conchifera, the few occurring belong usually to the *Aviculidæ*. A single species of *Murchisonia* as yet represents the Gasteropod order: this species is found at the Baton River. Two species of *Orthoceras* occur, but no other Cephalopod has been found.

Of Crustacea belonging to the Trilobita, two genera, each represented by a single species, are known. Both occur at the Baton River.

Corals form the great feature of the upper limestone. Many of these are of great size, specimens occurring more than two feet in diameter. *Fenestella* and abundant Encrinite remains occur in the slaty and chertose beds.

As elsewhere, the Upper Devonian rocks of New Zealand have been shown to be closely related to the generally-associated Maitai formation; neither the lithological characters of the first, nor the stratigraphical relations of the last, admit of a close connection with the Reefton Devonian beds. On the other hand, the evidence is well nigh conclusive that there is between the beds under consideration and the Upper Silurian strata of the Mount Arthur Range such community of character and fossils that, in view of this, the Reefton beds may safely be considered as belonging to the Lower Devonian period, and to the lower connected sequence of Palæozoic formations developed in New Zealand.

As yet these Devonian beds have not proved rich in metallic minerals. Galena may possibly be found associated with the limestones. A supposed occurrence of this ore on the north side of the Murray's Creek saddle has already been noticed. Quartz veins of more than a few inches in thickness do not occur, or have not yet been discovered. One near the source of the right branch of Lankey's Creek contains a good deal of pyrites. A good deal of iron sulphide occurs in the dark bituminous slates and mudstones of the Rainy Creek section (*see* notes on this: Geological Reports, 1873–74, p. 89). When last at Reefton there was some talk of silver being found in these beds at Rainy Creek; but so frequently is grey iron-pyrites mistaken for an ore of this or for silver itself, that, knowing the occurrence of such iron compounds at the place indicated, I concluded that here another mistake had been made.

The black bituminous pyritous mudstones which at various places are found between the head of Lankey's Gully and Rainy Creek might possibly be made to yield mineral oil. A specimen, however, which was analysed in the Colonial Laboratory, gave no indications of this, and proved to be of a graphitic character.*

As building stone the cherts, although of good colour, are too hard generally for hewn-work. In some parts, notably between the left branch of Lankey's Creek and the Inangahua River, the red cherts are sufficiently ferruginous to be looked upon as an iron ore.

* In this connection I had described to me a deposit apparently surrounding a spring of mineral water, the locality of which is to the south of the Rainy Creek Reefs and east of Merry-Jig, consequently in the direct strike of the Devonian rocks. The deposit in question was described as a yellowish-white soft substance, which ignited at a low heat, burning freely. My impression was that this might have some connection with these carbonaceous Devonian rocks.

The limestones will yet prove of value to the district for the satisfaction of its requirements for building, and other uses to which lime is put; and as ornamental marbles the purer parts of the madrepore limestone will rival anything of the kind elsewhere. The Inangahua County Council prepared for despatch to the late Exhibition held at Christchurch a block of black marble from the lower limestone. This took a very fair polish, but there is too much carbonaceous and argillaceous matter present to admit of its being of first-class quality for such purposes. This objection does not apply to the madrepore limestone, and, when the cost of transit is less than at present, something may be done with the latter.

The following is a list of the rock and other specimens collected from these Lower Devonian beds:—

Rocks.

1. (Labelled No. 44.) *Grey chert.* Locality: Murray's Creek, a few chains below the junction of Coal Creek. This rock belongs to the higher part of the lower cherts, which in this locality are in near contact with the auriferous rocks on the west side of Murray's Creek.

2. (Labelled No. 61.) *Black carbonaceous or bituminous mudstone, often pyritous.* Locality: The upper part of the right-hand branch of Lankey's Creek. The specimens collected are harder than the general average of this rock. *In sitû* the rock is liable to be deeply decomposed, probably on account of disseminated pyrites decomposing in it. Under such circumstances it assumes the character of an unstratified mudstone, and in this condition strongly resembles some of the less clearly laminated shales associated with the coal-bearing beds of the district. This peculiarity is strongly marked in the upper part of Lankey's Gully, where these beds, chancing to underlie the auriferous cements at the old battery site there, were by myself and others mistaken for coal shales underlying the cements. In the clearer sections now seen their true position is plain, and their being part of the Devonian sequence is beyond doubt, as thin beds of the lower limestone are interstratified with the mudstones. The same beds have been noted in the section along the north bank of the Inangahua and at Rainy Creek. The result of the analysis of this rock has already been given at page 115.

3. (Labelled No. 62.) *Cherty hæmatite, or red chert.* Locality: The left branch of Lankey's Creek. Forms the upper division of the lower cherts under the dark-coloured limestone, and is more or less ferruginous, sometimes to a considerable degree.

4. (Labelled No. 63.) *Cherty hæmatite, red chert.* Locality: The right bank of the Inangahua River, a short distance above the bridge on road to Rainy Creek. Same remarks as for No. 3.

5. (Labelled No. 64.) *Cherty hæmatite, red chert.* Locality: That of specimen No. 4. Same remarks as for No. 3.

6. (Labelled No. 65.) *Grey fossiliferous limestone.* Locality: The head of the Keep-It-Dark water-race. This rock will take a high polish, and is an excellent material for the production of lime. In the locality where the specimen was taken it does not appear in mass of such quality as would make it valuable as a building material. A similar rock is said to occur near the source of the creek on the opposite side of the river, and joining the Inangahua a little below the bridge.

7. (Labelled No. 66.) *Black fossiliferous limestone.* Locality: The right bank of the Inangahua, at the bridge crossing to Rainy Creek. The specimen represents the lower fossiliferous limestone, distinguished from the upper or madrepore limestone by the absence of corals in it.

8. (Labelled No. 67.) *Calc-spar.* Locality: Near the bridge crossing the river on the road to Rainy Creek. Occurs in cracks and fissures in the lower limestone.

9. (Labelled No. 68.) *Grey chert.* Locality: The right branch of Lankey's Creek. Belongs to the upper cherts between the two limestones.

10. (Labelled No. 69.) *Grey fossiliferous chert.* Locality: The right bank of the Inangahua River, between the first and next little creek higher up the river than the bridge, on the road to Rainy Creek. This specimen is from the lowest beds which have been proved to be fossiliferous.

11. (Labelled No. 70.) *Pink or flesh-coloured chert.* Locality: Right bank of the river a little above bridge to Rainy Creek. Same remarks as for No. 3.

12. Labelled No. 71. *White soft chert.* Locality: Bridge crossing the Inangahua River, on the road to Rainy Creek. This specimen represents the upper cherts between the two limestones, and, in the locality whence taken, is soft enough to be mistaken for coal-sandstone.

13. (Labelled No. 72.) *Dark-grey fossiliferous chert.* Locality: Right bank of the Inangahua, above first creek beyond the bridge crossing to Rainy Creek. Contains obscure fossils, apparently Encrinite stems; but these do not show the denticulated surface of the stalk sections.

14. (Labelled No. 73.) *Decomposing cherty slate.* Locality: Johnson's cement claim, on the spur between the two branches of Lankey's Creek. This rock, which is confined to the locality of the specimen, lies between No. 2 and the lower cherts developed to the eastward.

15. (Labelled No. 119.) *Fossiliferous slate.* Locality: Lankey's Gully. This rock is the highest and youngest of the Lower Devonian beds, as developed in the vicinity of Reefton, and is usually that in contact with the auriferous series, or that part of it west of the Devonian belt.

Iron Ores.

16. (Labelled No. 62.) *Hæmatite, cherty.* Locality: Left branch of Lankey's Creek. Contains iron.

17. (Labelled No. 64.) *Hæmatite, cherty.* Locality: Right bank of the Inangahua River, at first creek above the bridge on the road leading to Rainy Creek. Contains iron.

Fossils.

Forty specimens of the more abundant and characteristic fossils were deposited at Reefton. To these local collectors may add largely, and especially by getting together the different species of corals, of which the upper limestone will yield an abundant supply. To local collectors must be resigned the task of fully representing the Fauna of these rocks, and it is to be hoped that those having leisure to do so will avail themselves of their opportunities, as there can be no doubt that interesting discoveries await them.

A considerable collection of fossils was made in addition to the above, which have been deposited with the Geological Survey collections at Wellington.

CARBONIFEROUS.

The Reefton Auriferous Series.

Syn.—*The Maitai Formation (Carboniferous); The Mount Torlesse Formation (Haast); The Westland Formation (Haast).*

The auriferous reefs of the district are as yet confined to this series, and the formation has therefore a peculiar interest to those engaged in mining speculations. It is found over a considerable breadth of country between the south branch of the Inangahua and Grey Rivers; but in this direction scarcely any examinations have been made, and how far it is obscured by coal rocks or younger deposits has yet to be ascertained; likewise, to what distance south of Rainy Creek it is divided into two distinct areas by the outcrop of the Devonian beds, which latter rocks are supposed to continue for some distance in that direction. In December, 1875, Mr. Cox and myself crossed the country from the Inangahua, six or seven miles above Reefton, past Rainy Creek to Merry-Jig, and thence to Maori Creek, reaching the valley of the Little Grey by way of Anthony's Flat; and, with the exception of Devonian strata and coal-bearing rocks, met with in the vicinity of Rainy Creek, saw none other than auriferous rocks, except superficial gravels then being worked for gold at various places. The country to the eastward of the line followed by us was without high ranges for a considerable distance, and apparently ridge after ridge of auriferous sandstones and slates continued for several miles in this direction.

From Rainy Creek northwards the auriferous rocks are separated by the Devonian formation into two distinct belts of country,

which, thus parted by the whole linear extent of the Devonian formation, are again united between the north branch of the Inangahua River and Boatman's Creek.

On the disappearance of the Devonian rocks where stated, the auriferous series continues to the northward as a single exposure, flanked by coal-bearing rocks on the Inangahua Valley side of the range formed by them, and in the upper part of the valley of Boatman's Creek by coal-bearing strata, or the great breccias underlying these. In following Boatman's Creek to its source it may be proved that yet another outcrop of the auriferous rocks is there present, corresponding to that seen on the eastern side of Garvie's Creek, where the coal rocks resting on the auriferous series break the eastern belt into two; which there, however, has but a superficial effect, the auriferous series being traceable along the lower flanks of the hills continuously.

In the valley of the north branch of the river the coal rocks reach to and make junction with the granite belt, and seemingly do so for some distance in the direction of the source of Boatman's Creek. Yet there are vague reports of the presence of slaty rocks and massive reefs full of minerals in the upper part of Boatman's Creek at a point beyond the first granite belt, as the great granite breccias there present are called by the prospector. However this may be, the presence of younger rocks in the upper part of the creek narrows the breadth of the area of auriferous rocks, which is more and more narrowed, though not from the same cause, as it is followed yet farther to the north. At Larry's Creek the breadth of the outcrop is inconsiderable, and, though not here terminating, little is known of the rocks on this side of the valley farther to the north.

In the bed of the Buller River, at the Inangahua junction, auriferous rock, containing large reefs of white quartz, is seen. A large area of country beyond the Buller is formed, where coal-beds are not present, of auriferous rocks, but these do not at present come under consideration.

At Larry's Creek a mile and a half is the full breadth of the exposure of these rocks, and this varies according as the granites stand forward towards the Inangahua Valley, or the younger Miocene gravels rise on to the flanks of the range formed by the auriferous series. At Boatman's the breadth is not less than three miles, and would have been much greater but for the presence of younger rocks occurring in the manner already described.

Near Reefton, between the two branches of the Inangahua River, the western area from Cement Town to the high terrace at the back of Reefton has a breadth of two miles and a half; south of Reefton the breadth increases rapidly.

On the eastern side of the Devonian belt the distance from the upper part of Lankey's Creek, where the junction takes place in the main branch, to the western side of the granite belt, directly

across the strike of the strata, is at least three miles. On the south side of the Inangahua the distance between the Devonian belt and the river-bed is not great.

The rocks of this series are not varied. In great part they consist of gritty sandstones of different grain, one element of whose composition is of a readily-decomposable character, and hence under continued exposure they have at the surface a tufaceous appearance. Some of these are very fine-grained; usually the sand-grains are of such a size as to be prominently visible. In the coarser specimens the grains are angular, and the rock thus assumes the character of, and in fact is, a fine-grained breccia. However, in no case do these coarse-grained rocks assume the character of a pebble-bed or conglomerate.

Nearly of equal importance as a constituent of the formation are its blue and pale-green slates, alternating frequently with the sandstones, and which in a prominent manner are usually developed along the lines of softer country in which the great body of the reefs are worked, giving in fact their special character to such belts of country.

In the higher part of the series, as developed in the immediate vicinity of Reefton, there occur on the Victoria, Phœnix, United, Inglewood, and other mining leases in the same neigbourhood syenitic diorites, associated with diabasic calcareous rocks, with which, and in the reefs nearly associated with such rocks, carbonaceous minerals, such as graphite, occur. These, whatever their origin, either as products of eruption or of metamorphic action, are equally distinct from the general body of the series to which they belong.

The same rocks are found, with some additional varieties of slate and sandstone, at Specimen Hill, in Little Boatman's Creek, and in a small branch of the main creek (Boatman's Creek) near the Welcome Mine.

In the northern end of the district, the rocks of this series differ somewhat from those which have already been noted. At Larry's Creek they have suffered a degree of metamorphism which there gives them a distinct peculiarity when compared with the same rocks in other localities. Mica is perhaps not in a greater degree a constituent of the rocks at Larry's Creek, but their darker colour makes the grey varieties of this mineral more apparent in the sandstones there.

In the southern part of the district the rocks of the auriferous series are of the same character as in the neighbourhood of Reefton. In places, the sandstones (more generally those of finer grain) and the slates have much pyrites disseminated through them, as on the south side of the Inangahua River, opposite the Town of Reefton. There the rocks at the surface are stained to a deep ferruginous colour; and by segregation of the oxidized materials of the pyrites thin veins of fibrous hæmatite are produced.

Chester do.; 109. Cosmopolitan; 110. Inangahua Valley do.; 111. Dunedin appl.; 112. Champion do.; 113. Champion Extended do.; 114. South Golden Treasure do.; 115. Saturn, Mars, Juno do.; 116. Queen do.; 117. Herald do.; 118. Keep-It-Dark do.; 119. Royal George do.; 120. No. 2 Keep-It-Dark do.; 121. Daylight do.; 122. Pandora do.; 123. Rolleston; 124. Bendigo; 125. Lucky Venture; 126. Dido; 127. St. Andrews; 128. Orient; 129. Rainy Creek; 130. Garden Gully; 131. Malakoff; 132. Inkerman; 133. Balaclava; 134. Sebastopol; 135. Triumph; 136. Hustler's; 137. Waterloo; 138. Lady Mary; 139. Hustlers No. 1; 140. Souvenir; 141. Souvenir; 142. Lucknow; 143. Peabody; 144. North Souvenir, now Redan; 145. Washington; 146. Surprise; 147. Britannia appl.; 148. Great Britain do.; 149. Van do.; 150. Advance do.; 151. Suez do.; 152. Globe; 153. Oriental; 154. Junction; 155. Enterprise; 156. Union; 157. Great Western; 158. New Zealand Antimony Company; 159. Argus; 160. Wide Awake; 161. Virginia City; 162. Nevada; 163. Hidden Treasure; 164. Divide appl.; 165. Graphic do.; 166. Cure do.; 167. Grand do.; 168. West Coast; 169. East Coast appl.; 170. Conqueror do.; 171. Union Extended do.; 172. Coal lease; 173. Soldiers' Creek; 174. Golden Crown; 175. Golden Point; 176. Success; 177. Troilus; 178. Golden Point No. 2 appl.; 179. Maori Chief do.; 180. Criterion do.; 181. Royal; 182. Alexandra; 183. Hector; 184. Minerva appl.; 185. Shannon; 186. Bonanza; 187. South Bonanza; 188. Montezuma; 189. Golden Spur; 190. Royal Mint; 191. Highlander; 192. Cressida; 193. Kohinoor; 194. Great Republic; 195. New Chum; 196. South British; 197. Morning Star; 198. Royal Saxon; 199. Golden Streak; 200. Lady Gordon; 201. San Francisco; 202. Evening Star; 203. Royal Exchange.

The physical features of the country over which these beds are found are modified according as the beds are spread over a great breadth of country, or form a single range having a greater elevation, or are found flanking a range in which the higher parts are formed of other and older rocks.

In the hilly southern part of the district, where the breadth of the formation is considerable, and the elevation above the lower levels of the surrounding country not great, a series of approximately parallel ridges rise one after the other in an east-and-west direction; but this apparent regularity has been in a great measure destroyed by the spur ridges from these, bounding the valleys of the smaller streams and rivulets. By these and the larger streams the country is in places much cut up into narrow ridges and deep gullies, though when looked at from a moderate height and at a distance this is not so apparent as an actual traverse of the country proves it to be. The total result is an apparently irregular conglomeration of high hills, or mountains of moderate height, none of which greatly dominate the rest.

Between the two main branches of the Inangahua River this character of the surface is somewhat modified. In the whole of the district north of the south branch there is a tendency of the beds to form themselves into one distinct range, the axis of which, for some distance, is occupied by the Devonian rocks. The trend of this is slightly convergent towards the granite mountains to the east, and this causes it to coalesce with, and, as a distinct range, disappear on, the western flanks of the crystalline mountains yet farther to the northward.

The two main branches of the Inangahua, where they cross the auriferous rocks, being approximately parallel to and at no great distance from each other, dissever from the areas to the south and north a portion of the auriferous rocks. On the block of country so divided, denudation, relieved in a north-and-south direction, has proceeded rapidly, forming a range of mountains parallel to its formative cause—the river-courses. The further eastern end of this rests on the western slopes of the Victoria Mountains, and in a western direction after the Devonian belt is passed the range breaks up into a three-fingered termination, the more southerly spur of which, lying between Murray's Creek and the Inangahua River, terminates at Black's Point. The middle ridge, between Murray's Creek and the Inangahua River on the one side and the drainage down Deep Creek and Burke's on the other, terminates on the eastern side of the high terrace table-land at the back of Reefton. The third and last lies between the last-mentioned streams and the north branch of the river. Where not horizontal, all the strata in this range strike across it.

North of the Waituhi these rocks form a distinct block of mountains, whose linear extension is N.N.E., nearly parallel to the strike of the strata, and, though not very definite as a con-

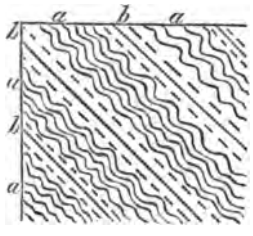
tinuous leading ridge (its heights being a hummocky assemblage of mountains in no direct line, sometimes on one flank, sometimes on the other), it is broken only by Boatman's Creek, till it blends with the slopes of the granite range at Larry's Creek.

The minor features of the country formed by these rocks are not generally so boldly precipitous as within the boundaries of the Devonian formation. Yet, where its strata are cut deeply into by the streams crossing its strike, precipitous heights are formed, as in the gorge of the Inangahua above Reefton, in Murray's Creek, in Deep Creek, and at Boatman's. The highest precipices in the upper part of Lankey's Gully are within the boundary of this formation.

As illustrative of the arrangement of the auriferous rocks lying west of the Devonian belt, the section from Reefton to the bridge over the river on the road to Rainy Creek is the most important, since it takes in its course some of the principal mines, and is the most complete as regards the amount of detail available for the construction of such a section, although not extending so far west as the section on the south side of the river.

The section on the south side of the river in its western end shows in its strata some of the peculiarities of these rocks, and, as really a portion of the Reefton section, it may be here first described.

Commencing at the lower end of the gorge, opposite where the last rocks are seen on the Reefton side, the beds here are silky pale-green slates and moderately fine-grained sandstones. The strike here is difficult to observe, as the alternations of the strata are not well marked, and the beds are contorted so as to produce minute foldings resembling ripple-marked surfaces. This character chiefly affects the pale-green slates and the less massive beds of sandstone. Where the sandstones are in beds of sufficient thickness they are not affected by these contortions, except on their upper and under surfaces, where they make contact with the slaty beds. The following sketch is intended to illustrate this character as seen not here only, but also at many different points in most of the sections examined:—

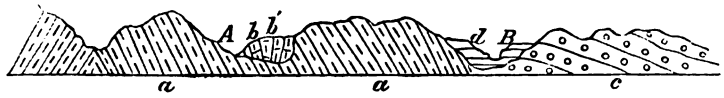


Sketch showing contorted structure of the green slates of the Auriferous Series. *a*. Slates. *b*. Sandstones accommodated to the contortions of the slates, yet showing partings indicating the true bedding.

The finer-grained sandstones are charged with disseminated pyrites in minute crystals, while iron in another form gives to the slates their green colour: both oxidizing, the rocks are thus subject to decomposition, and, as a consequence, are stained a rusty colour at the surface and for some distance below it. Segregation of this ferruginous matter produces thin veins of fibrous hæmatite, which, following the contours of the specimens or surfaces exposed, have a tendency to cause a nodular or concretionary appearance of structure. At the quarries whence has been taken the material used for the protective works which direct the course of the Inangahua River, these beds are well seen: there the strike is N.–S., and the dip W. at an angle of 75°.

Further west, opposite the end of the bridge, and for some distance along the Greymouth Road, similar rocks, stained red with ferruginous matter, are exposed. They appear to dip to the west, but this is difficult to determine. Before reaching Breen's Hotel, at the junction of the road to Devil's Creek, coal rocks apparently, but at the surface younger rocks, make junction with the auriferous series.

If not actually under this line of section, and there obscured by younger recent deposits, an outcrop of the coal rocks is seen nearly in Liverpool Davis's Gully. These are tilted to high angles, and dip to the west. They are shown in the following sketch, and will be more fully described under the proper heading:—



Sketch-section south bank of the Inangahua, near Reefton. *a.* Rocks of the auriferous series. *b.* Fireclays belonging to the coal-beds. *b'.* Hæmatite and ferruginous clays belonging to the coal-bearing series. *c.* Upper Miocene gravels, the eastern margin of the beds forming hills between Reefton and Squaretown. *d.* Granitic grit and sands of uncertain age. *A.* Liverpool Davis's Gully. *B.* Saddle leading to Soldiers' and Devil's Creeks.

In the Reefton section, on the opposite side of the river, commencing with the green slates exposed in the edge of the terrace at the back of the town, these rocks on the tramway line to the New Durham Coal Mine are seen to strike N.–S., but are there badly exposed, much contorted, and the dip, whether to the east or the west, can scarcely be made out: it appears to be to the east at high angles. For a short distance the older rocks are obscured by the gravels of the high terrace, but are again seen at the quarry opened at the end of the gorge, and alongside the road leading to Black's Point. In these quarries false bedding, caused by joints in the sandstones and the contortions of the slates, renders the dip obscure; but it appears that the strike is to the N.E., and the dip N.W. at an angle of 45° to 50°. The rocks are grey sandstones and decomposing slates, such as are seen on the south side of the river, but with the special character of ferruginous stain less marked.

Further on, towards Black's Point, the rocks appear to dip in the contrary direction, and are sandstones and blue and green slates alternating. Solid rocks show in the river-bed, and a few chains within the gorge an exposure of sandstone on the roadside shows the dip at this point in an up-river direction. The hill-slopes, however, are here covered with *débris*, and the rocks *in sitû* are not readily seen. Some few chains further on sandstones predominate; and here occurs the coarsest rock of the series yet met with in the whole district. This has already been alluded to in describing the lithological characters of the formation, and will again be noticed in the descriptive list of its rocks, so that it need not be dwelt on in this place.

Nearly half-way to Black's Point, alternating sandstones and slates, evenly stratified, are found in a nearly vertical position. Their strike is N. 25° E. Yet further towards Black's Point the dip is eastward at lower angles, and the rocks are alternations of blue slates and sandstones, with occasional beds of green slate. There seems to be less contortion of the latter here than in the western end of the section. Gradually the sandstones acquire a decided predominance over the other rocks, till these culminate in a heavy mass of such rock, forming a barrier to the river's direct course, at the pool a little below Black's Point.

Resting on this mass of sandstone, which forms a bold spur running to the crest of the ridge above Anderson's Reef, and constitutes an equally bold feature on the south side of the river, are crushed beds of dark-blue slates, parted by irregular bars of sandstone. No definite strike or dip could be made out in these latter, and it seems certain that they are either displaced from their original position by a fault, or, by the resistance presented in the sandstone mass to the west, the general movements of the strata have resulted in the broken and crushed condition of these slaty beds. Considerable movement is shown by the presence of pug courses, and in the slates being broken diagonally to the planes of bedding, thus producing a mass of pitcher-shaped pieces, having obtuse and acute angles.

Resting on these broken beds, and exposed at the eastern end of the slip here formed by both, are green slates alternating with ribs of sandstone. The strike here is N. 10° to 20° E., and the dip is eastward at angles varying from 20° to 40°.

Across this part of the section should be the strike of Anderson's Reef, and a belief is entertained that it will be found in this line at lower levels than its outcrop on the side of the hill. It would be idle speculation, and not connected with my present subject, to risk opinions respecting the continuance of this on the south side of the river, where, in the upper part of Auld's Creek, quartz reefs are known. Suffice it to say this seems to be the course of the softer broken country just described, and in which the approximate course of the bed of Auld's Creek appears to have

been excavated. Beyond the slip on the Reefton side of Black's Point, a gully and small creek divide the spur on which is Anderson's Reef from that between it and the lower part of Murray's Creek. In the face of the latter spur is the entrance to the low-level tunnel. This is being driven in a north-east direction (?) under this spur, and is intended eventually to reach the line of reefs of which the Golden Fleece Mine is at the northern end, as far as traced, and the Wealth of Nations at the southern end. The materials forming this spur, as far as the proposed tunnel has been excavated, are grey sandstones and bluish-green contorted slates: the dip of the beds is at high angles to the eastward. The sandstones are pyritous, and become rusty-brown after exposure for some time, but exposure long continued further bleaches them to a light-grey colour.

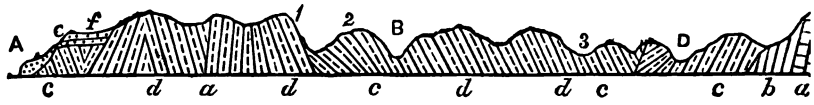
The tunnel is now being driven through rocks the continued beds of which are exposed on the left bank of Murray's Creek, and show with a predominance of grey sandstones, striking N.–S., and dipping E. at an angle of 60°. Following the road from Black's Point to Crushington these rocks appear on the river side of the spur, and are there associated with contorted green slates, not decomposed, but as characteristic in structure as those on the south side of the river at Reefton. Close to these green slates the strike is more to the east, being N. 30° E., and the dip E.S.E. at an angle of 40°. In the deep embayment between this spur and the next further east between that and Crushington the strike is the same as the last noted, and the dip at an angle of 30°. Here the succeeding rocks are blue crushed slates, &c., in every way resembling those in the slip at Black's Point. More sandstones and slates succeed these crushed beds, which are fairly seen in the point rounding which Crushington comes in view. Here the strike is N.–S., and the dip E. at angles varying from 60° to 70°. Near the Wealth of Nations battery the strike of the sandstone is N.–S., and the dip E. at an angle of 50°. From the foot of the river-flat at Crushington to beyond the Nil Desperandum Mine the section at the surface is not very clear; the strata, however, still dip to the east, at a high angle. This is seen in the lower levels of the Keep-It-Dark Mine. Grey sandstones and green sandy slates are the prevailing rocks, but blue slates appear in the corner where the road turns sharp to round the point below Crushington: seemingly there is here a second repetition of the blue crushed slates at Black's Point. In the interval the section is obscure, but before reaching the mouth of Lankey's Gully the beds form a syncline, and for some distance before reaching the mouth of the gully they dip to the west. When next distinctly seen within the watershed of Lankey's Creek the strike of the beds is N.–S., and the dip W. 50° to 60°. The rocks here, where showing at the surface, are green contorted slates.

Between the lower part of Lankey's Gully and the Devonian

belt towards the bridge crossing the river, the auriferous rocks form an isolated hill, divided from the bold spur of Devonian rocks by a gully and saddle at its head, along which gully runs the junction between the two formations. Two-thirds the distance from the mouth of Lankey's Gully to this point the last observation of strike and dip of those rocks on this line of section was made, showing the strike to be N. 30° W., and the dip S.W. at an angle of 65°. The rocks there, at the foot of the timbered flat below the bridge over the Inangahua, and where a bywash of the river here sets against the hard rocks, are pyritous sandstones and green nodular pyritous slates, each crystal of pyrites being apparently nested in a coating of the slaty material, and, though this is not seen when the rock is split, it is indicated by a tuberosity on the surface of the specimen. These and the silky character of the rock give these slates somewhat the appearance of a schistose rock, a character yet more marked in a like rock of this formation at Langdon's Hill, near Brunnerton.

A number of observations made in Lankey's Gully, all at no great distance from the junction with the Devonian beds, show the average strike to be nearly N.–S., and the dip W., usually at high angles. An exception as regards the dip is seen a little above Matheson's claim, at the angle where the right branch turns to the north, at which place the dip is at high angles to the east; and yet another is seen a few chains on the road to the Lankey's Gully Coal-mine, after that has left the bed of the creek.

The following sketch shows the arrangement of the beds along the line of section described, with which that illustrative of the Devonian beds along the northern bank of the Inangahua is continuous, and which will be further continued from the eastern side of the Devonian belt past the mouth of Garvie's Creek to the junction of the auriferous rocks with those of the granite range, this latter being given in illustration of the coal rocks in Garvie's Creek. (*Vide post.*)



Section from Reefton, south-east, past Black's Point and Crushington to the Devonian belt near the bridge over the Inangahua River. *a.* Madrepore limestone (Devonian). *b.* Blue fossiliferous slate (Devonian). *c.* Slates of the auriferous series. *d.* Sandstones of the auriferous series. *e.* Coal shales and sandstones, coal-seams. *f.* Miocene (?). Pliocene gravels 500 feet above Reefton. *g.* Recent gravels of the Inangahua Plain. A. Reefton. B. Murray's Creek, Black's Point. C. Crushington, Wealth of Nations, and Keep-It-Dark Mines. D. Lankey's Gully. 1. Anderson's line of reef. 2. Low-level tunnel. 3. Smith's line of reefs.

Between Reefton and the syncline west of the mouth of Lankey's Gully there may be a thickness of some 5,000 feet of strata, but this estimate may be modified according as the beds

prove to be repeated by faults, the proofs of which are not as yet clear. Something like three alternations of a distinct sequence are seen in this section: first, between Reefton and the slip at Black's Point; second, from the slip to the rocks of like character in the deep embayment on the road from Black's Point to Crushington; and, third, from the point west of Crushington to the highest beds of the syncline.

From Crushington to Lankey's Gully the section is not clear enough to make determinable the exact position of the syncline, but this must occur somewhere near where shown. Its position has been ascertained in Murray's Creek, and on the hill east of the Ajax Mine (Golden Fleece), and a line drawn over these two points brings it close to the point where shown in the above wood-cut.

On the west side of the syncline are situated all the reefs worked on the N.–S. line, from the Wealth of Nations to the Golden Fleece, and it appears that there are two or more lodes parallel to each other on this line. Anderson's line, which has not as yet been very successfully developed, lies considerably to the westward of this, and in or adjoining the first belt of soft country. A third line of reefs occurs on the east side of the syncline, worked or being prospected from the United Inglewood to the Golden Treasure mining leases. This line is notable for the amount of antimony ore occurring either in the auriferous lodes themselves or in their near vicinity.

The next section claiming attention is that along Murray's Creek, from Black's Point to Cement Town. This is strictly a repetition—a part of the last, but running more directly across the strike of the beds—showing, however, one or two points of interest near its eastern end, namely, the position of the syncline near the last small stream joining Murray's Creek from the north before reaching Cement Town and half-way between this point and the Energetic's battery, a pyritous rock indicating the vicinity of the syenitic and diabase rocks farther north, at much the same relative distance from, but on the other side of, the syncline.

Section of the auriferous rocks from Black's Point up Murray's Creek to Cement Town. *a*. Devonian cherts and slates. *b*. Sandstones and slates of the auriferous series. *b'*. Dioritic rock (?). *c*. Coal rocks at Cement Town. A. Murray's Creek. B. Black's Point. C. Cement Town.

The section-line from the saddle at the head of Murray's Creek has not been examined with sufficient care to be here detailed. All that has been made out is that the strata dip west to the vicinity of the Inglewood and Phœnix Mines, and that in the North Star tunnel, and further south-west in the Phœnix Mine, occur the syenitic and diabasic rocks which have been

already mentioned. Shortly to the west of the latter mine the syncline must pass to the northward, and show in the upper part of Deep Creek, but this has not been explored for the purpose of ascertaining its position.

The auriferous rocks of the section, from the eastern side of the Devonian belt on the north bank of the Inangahua to Garvie's Creek, and to their supposed junction with the granites farther east, are of the same character as those on the west side of the Devonian belt—namely, alternations of sandstones and slates—the only difference being that as far as yet known the green contorted slates are not so abundant on this side of the belt. The arrangement of the beds is as a syncline, one side of which rests on the upturned edges of the Devonian rocks, the other on the granitic rocks forming the lower slopes of the Victoria Mountains. The higher beds and the syncline occur at a point west of where Garvie's Creek leaves the hills; at all events the first rocks met with west of this dip to the eastward.

In a slip near the foot of the river-flat, opposite the junction of Rainy Creek, the rocks of this series strike N. 10° E., and the dip is E. 50° to 55°. The auriferous rocks of this section are shown in the sketch at page 149.

East of the Devonian belt, where crossing Rainy Creek, the auriferous rocks are prominently sandstones; their strike in the lower part of the creek is N.–S., and their dip E. at an angle of 50°. Nearer the junction made with the Devonian cherts the strike is N. 30° W., and the dip S.W. at an angle of 85°.

At Boatman's, where first appearing from beneath the coal-bearing strata, the rocks of the auriferous series at the junction of Little Boatman's Creek strike N.–S., and dip at high angles eastward. Between Capleston and the Just-in-Time battery the strike is still N.–S., and the dip E. at 70°. Farther up the creek the dip increases, till at the Imperial shaft it is vertical. Beyond the Imperial Mine there is for some distance an irregularity of the dip, but the strike still continues N.–S.: this passed, the dip is regular and to the west at high angles.

This section, as far as examined on the present occasion, is as follows:—

Section through the gorge of Boatman's Creek. *a*. Sandstones and slates of the auriferous series. *a'*. Position of the syenitic rocks seen further north. *b*. Coal formation with coal-seams. *c*. Upper Miocene gravels—auriferous. *d*. Pliocene (?) and Recent gravels. A. Capleston, junction of Little Boatman's Creek. B. Junction of creek passing the Welcome Mine.

The rocks of the above section differ in no important particulars from those of the Reefton section; perhaps the sandstones and blue

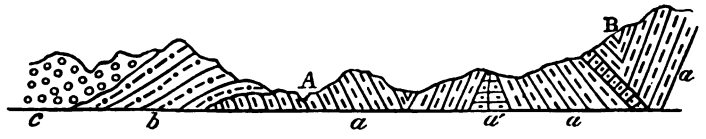
slates are, if anything, more abundant. It would, therefore, be a needless task to detail these as minutely as has been done for the other section, unless indeed there were special reasons for doing so, which do not appear.

In the section at Little Boatman's Creek, from the coal-mine at the junction of the two branches to Specimen Hill Mine, the rocks of this series are not everywhere well exposed. Below the junction in the main creek the strike is N.–S., and the dip E. at high angles. At the foot of the rise to Specimen Hill the dip is to the west; and close to an outcrop of syenitic rock on the south bank of the creek the strike and dip are irregular, but on the up-hill or east side the dip is regular and eastward.

At the mouth of the lowest tunnel on Specimen Hill Lease the strike alongside a syenitic band is S.E., and the dip N.E. at an angle of 45°. In the two upper drives the strike generally is N.–S., and the dip at high angles is east and west without apparent regularity, but evidencing the presence of a synclinal arrangement, disturbed and irregular in its dips, as in the main branch of Boatman's above the Imperial Claim.

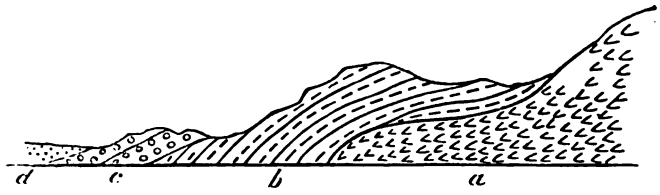
On the whole there is much confusion of strike and dip in the Specimen Hill Mine, which may be attributed to the presence of the syenitic rocks in the mine or near by. These, where seen in the south bank of the creek, some distance below the mine, appear as an intrusive mass, disturbing the surrounding strata. At the mine itself they appear to be bedded with the other rocks, and are there associated with green diabasic rock, in which lime as calc-spar is not of infrequent occurrence.

Graphite occurs freely in connection with the quartz lodes in the mine. The following sketch shows the rocks of this section from the coal-beds on the west side of the creek at the junction of the branches to Specimen Hill:—



Section west to east, Little Boatman's Coal Mine to Specimen Hill. *a*. Slates and sandstones of the auriferous series. *a'*. Syenitic and diabasic rocks in auriferous rocks. *b*. Coal formation, with coal-seams. *c*. Miocene gravels. A. Little Boatman's Creek. B. Specimen Hill.

With rocks older than themselves, those of the auriferous series are in contact with but the Devonian formation, and the granitic portion of the metamorphic series. Where resting on the latter at Larry's Creek, their mode and position have already been described. On the northern bank of Larry's Creek they rest on the granitic rock at a low angle, and in section the junction is traceable for a greater distance than is usual at their contact with other rocks. This is shown in the following sketch:—



Section showing junction of the auriferous rocks at Larry's with the underlying granites. *a*. Granite. *b*. Auriferous rocks. *c*. Gravels. *d*. Recent.

As to their relation to the Devonian rocks, the various sections described show conclusively that the auriferous series is not only the younger, but that it rests with marked unconformity on the older formation at all points where contact is made. However much individual sections may show this, the proofs stand forth in a yet stronger light when it has been ascertained that various Devonian rocks make junction at different points on the same side and on different sides of the exposure of the older formation.

With the schistose rocks of the metamorphic series the relation of these rocks cannot at the present be determined, further than admitting that at Larry's Creek they have been so much altered that there is no improbability of their being also represented in the schists further east beyond the granite belt.

To all the younger rocks present in the district the auriferous rocks are unconformable. This might seem a superfluous statement, since the time-distance between rocks of the Carboniferous formation and those belonging to the Cretaceous period is so great; but it is not wholly so, since the condition of many rocks irrespective of their age may be such that the younger may have the higher antiquity assigned them. Nor have we to travel far outside the district for illustration of this, since in the great breccias at Hawk Crag, and filling the middle part of the Buller lower gorge, the said breccias might without greatly stretching the imagination have assigned them a Devonian age, and be regarded as belonging to the Te Anau series. With such rocks the Reefton auriferous series comes in contact along the south bank of the Waituhi, east of the Devonian belt, and hence the propriety of the above statement.

In attempting to identify the rocks of this series with distant developments of what is taken to be the same formation, first to be considered is the extension of the series to the northward. It has been stated (p. 97) that rocks belonging to this series form mountainous country north of the Inangahua Valley, and yet further in that direction the same rocks are present within the watershed of the Mokihinui River, where reefs are being worked or prospected. Continuing north, this series is over considerable areas overlaid by younger rocks, and has on its eastern side, interposed between it and the Silurian strata of the Wangapeka and Mount Arthur Districts, a formation of unaltered rocks not met with in the Reefton District.

This, the Te Anau series of Upper Devonian age, makes its appearance towards the sources of the Wangapeka and Karamea Rivers, and, striking north past the western slopes of Mount Arthur, forms the table-land (Salisbury Open) west of that mountain. The rocks of this are very dissimilar from those of the Reefton auriferous series, and are followed or closed by a massive development of limestone in the Mount Peel Range. This limestone belongs to the next succeeding formation, and is in fact the Maitai limestone at the base of that formation. On this rest rocks similar to the Reefton auriferous series, which has been shown to be developed northwards in this direction, and it is thus shown to be younger than the Te Anau series. Compared with each other, the Reefton auriferous series and the Te Anau beds are easily distinguished: the latter are mostly red and green breccias, having a great development, and are associated with serpentines, syenites, and other crystalline rocks, being thus wholly unlike the first-named series.

Comparing the Reefton beds with the rocks of the Maitai formation, and for this purpose selecting the typical section near the City of Nelson, saving that in this red slates are a feature not seen at Reefton, the rocks are much alike in character. No limestones lie at the base of the Reefton section, but a limestone which, from position and character, is rightly regarded as the equivalent of the Maitai limestone, has been stated to occur in the Mount Peel Range at the base of the supposed northern extension of the Reefton auriferous series. Green silky slates occur in no younger formation, and at both Reefton and Nelson these are a prominent feature. With the rocks of the Grey Valley above Brunnerton these Reefton beds are identical, and specially so in Langdon's Hill, where antimony lodes and auriferous reefs occur associated as at Reefton. Farther to the north on the coast-line twelve miles north of Greymouth, blue slates are a more abundant rock than at Langdon's, or perhaps at Reefton. These slates contain a fossil Annelid, which, with the *Inoceramus* found at Dun Mountain and in the Maitai River section, are the only fossils the formation has yielded from other beds than the Maitai limestone. This fossil Annelid is wide-spread over the South Island, and also in the North Island near Wellington and on the shores of Cook Strait. It occurs in the Taupo Range, where the rocks are fairly referable to the Reefton auriferous series. It is found in Eastern Canterbury, and along the east side and higher parts of the Southern Alps to the borders of Otago, and everywhere is looked upon as evidencing the presence of the Maitai formation. It occurs on the West Coast from Okarita (brought down by glaciers from the higher parts of the Southern Alps) to the Twelve-Mile, on the coast west of Reefton, and in beds not doubted to be the same as the Reefton auriferous series, though not everywhere in beds recognized as belonging to

the Maitai formation. That it belongs to such there is sufficient proof. (*See* Geological Reports, 1879–80.)

There is but little resemblance between the Reefton auriferous series and the Permian or Trias rocks of New Zealand, and, as shown, not much with the Te Anau formation as developed nearest to Reefton, so that, in a word, the auriferous series of Reefton can be the equivalent of no other than the Maitai formation.

Sufficient proofs are forthcoming to show that the Maitai formation near Nelson belongs to the Carboniferous period, the Maitai limestone yielding evidence of this in the shape of fossil shells and corals. The Reefton beds are therefore Carboniferous in age, and in position the equivalents of the English coal measures.

The mineral wealth of this series is as yet confined to gold and antimony. Of gold mines a number have passed their trial period, and have developed into steady, paying speculations. Many have a promising future before them individually; and the past year's work, proving (in the old-established mines which have been worked to deep levels) that at the greatest depths reached the richest stone is found, gives an assurance of continued prosperity for the field. The high yield of 1 oz. 7 dwt. per ton of quartz crushed (Gold Fields Report, 1882) shows that only the richest reefs can yet be profitably worked. The fact, then, that heavy calls on shareholders are at the present time being made shows a belief in the richness of the lodes being prospected, and promises a maintenance of the high yield per ton. Several of the mines have large bodies of stone up to 30 feet in thickness, so that a less yield per ton than at present rules may be sustained, and may actually be an evidence of increased prosperity.

The reefs generally have a north-and-south strike. In the southern end of the field they dip to the westward; at Boatman's they dip to the eastward; and in all cases at high angles. In the block of country between the two main branches of the Inangahua River it seems that there are three distinct groups of reefs, running approximately parallel to each other, and to these on the south side of the Reefton branch of the river a fourth line must be added, as to none of the three mentioned can the Golden Point and Devil's Creek reefs be referred.

The most easterly of these, lying nearest the Devonian belt, is distinguished for the amount of antimony ore associated with the auriferous quartz. The Phœnix and the United Inglewood are at the northern end of this line. The Golden Treasure limits it, as yet, to the south. It appears to pass into the watershed of Lankey's Gully, and to strike south in the near vicinity of the Devonian rocks to Rainy Creek.

Next to the west is the line commencing at Crushington and traced north across Murray's Creek to the Golden Fleece. The rich reefs on this line are well known. The Wealth of Nations

and Energetic Mines long sustained its reputation, and latterly the Keep-It-Dark has made it famous. The third and most westerly on the north side of the Inangahua has not been developed so fully as the other two, but no one supposes that the last has been heard of Anderson's line of reef.

At Boatman's there are seemingly two lines of reef: the Fiery Cross and Welcome line, and another farther to the west which is as yet only being prospected.

Had I devoted myself to a study of the various behaviour of the reefs in the different mines, it might have been possible to have arrived at important conclusions of practical value to those engaged in working them; but this was a work requiring so much more time than lay at my disposal that it could not be undertaken without interfering with the special object of my visit.

Antimony occurs either independently in lodes by itself, or in association with reefs of auriferous quartz. The lode on the west side of Auld's Creek, leased by Malcolm and Bayfield, contains no quartz except what is disseminated through the ore; the lode strikes S. 25° E., and is nearly vertical, or dipping at a very high angle east. The foot-wall is slate, the hanging-wall sandstone, and where ore is absent the lode-fissure is filled by a breccia gangue, derived from the adjoining rocks. Quite as rich and more continuous deposits of antimony occur in many of the gold mines. In the Souvenir Claim, Rainy Creek, there is such a mixture of auriferous quartz and antimony ore containing gold that the puzzle seems to be, whether this shall be worked as a gold or as an antimony mine: the proprietary are apparently oblivious of the fact that both products may be turned to account. In other cases this difficulty has been settled, perhaps not wisely, in electing to extract by the ordinary means of crushing as much gold as can be got, and allowing the antimony a place in the tailing-heaps, or conveyance to the bed of the nearest stream. Much valuable ore raised from the Golden Treasure and Welcome Mines is treated in this manner, and, what makes matters worse, under a clear appreciation of the loss thereby entailed. The defence set up is that there are no present means of treating this auriferous antimony ore in a more economical manner, and that the different directories desire that it should be utilized forthwith. There is no doubt a good deal of antimonious stone which perhaps would not pay to treat otherwise than as done at present, but there is no good reason why the richer ore should not be stacked and reserved for future treatment in a proper manner.

These antimonious portions of the lodes are reckoned poor in gold, this being according to the results obtained at the batteries. In the case of the Golden Treasure Mine much of this ore is left unworked, the antimony generally appearing on one side and the cleaner quartz on the other wall of the lode: nevertheless when I last visited the mine masses of good antimony ore 30 lb. to 50 lb.

in weight were being run into the paddock and passed through the battery with much ore of a more quartzose description.

Small quantities of galena are found in the Caledonian Mine at Larry's Creek, but this ore is absent or very rare further south. In no case does it occur other than as a rare accessory.

Iron is nowhere found except as sulphides or arseniates of iron, whether in the various mines or disseminated through the rocks.

Graphite is found in the Specimen Hill Mine, associated with and coating the flakes and laminæ of quartz.

When the lode-fissures were formed and charged with their present contents I have not been able to determine, but considerable movements have taken place since, and I much incline to believe that the principal syncline in the auriferous rocks has been formed subsequently. If, as seems likely, the reefs were already deposited prior to the period of the coal-formation, they must have suffered considerable dislocations and crushings during the time these rocks were being upheaved and elevated to their present position. We see some evidence of this in the Specimen Hill Mine. Later movements, it may be, have broken the quartz since the lodgment of the gold therein, and specimens are not rare of a flattened and striated character, which they could not have acquired in being won from the mines.

The following is a list of rock and mineral specimens collected from this series:—

1. (Labelled No. 16.) *Micaceous sandstone.* Locality: On road to Black's Point, from quarries near Reefton. The specimens are coarser in the grain than the usual run of the sandstones at this place.

2. (Labelled No. 17.) *Fine-grained slaty sandstone.* Locality: That of No. 1. These rocks, and a green slate which by an oversight has not been collected, form the strata at the western end of the Reefton section. They are liable to decomposition, and the same rocks on the south side of the river are often stained a rusty-red colour.

3. (Labelled No. 18.) *Coarse-grained sandstone.* Locality: Road from Reefton to Black's Point, about a quarter of a mile from Reefton. This rock, which is a mixture of angular grains of quartz and felspar, with here and there a crystal of iron-pyrites, is the coarsest-grained rock collected from the auriferous series. Most of its component particles are of nearly equal size — a tenth to an eighth of an inch. The felspar has partly or wholly decomposed, leaving the specimen cavernous at the surface, or showing in strong contrast to the quartz in the more solid parts of the specimen. The rock is very hard, and has the appearance of a grit or fine-grained breccia.

4. (Labelled No. 19.) *Green slate.* Locality: The hill-slope, Reefton side of No. 3. This is a characteristic rock of the auri-

ferous series, and equally so of the Maitai formation elsewhere. These green slates are remarkable for their contorted condition, the sandstones and blue slates being affected in this way to a much less degree.

5. (Labelled No. 20.) *Sandstone.* Locality: Slip on the river-bank a little below Black's Point. This rock is grey when freshly broken, and again weathers to a grey colour, but in the intermediate stage acquires a rusty-brown colour, resulting from the decomposition of iron-pyrites.

6. (Labelled No. 21.) *Blue slate.* Locality: The slip near Black's Point. The specimen is from an even-bedded rock, is of a silky fineness, and has a greenish tinge of colour.

7. (Labelled No. 29.) *Sandstone.* Locality: The hard bar of sandstone west side of the slip near Black's Point. This rock underlies the crushed blue slates in the slip, and in its various grain may be said to represent the sandstones of the series.

8. (Labelled No. 22.) *Blue slate.* Locality: Low-level tunnel, Black's Point. This rock shows the condition of the rock at a distance from the surface; it is evidently the same as No. 6, but has not, like it, been subjected to the influence of the weather.

9. (Labelled No. 23.) *Grey sandstone.* Locality: Low-level tunnel, Black's Point. Like No. 8 this specimen is from some distance inside the tunnel, and shows the condition of the sandstones at a considerable depth below the surface.

10. (Labelled No. 31.) *Decomposing slate.* Locality: Quarries, south side of the river, opposite Reefton. The irregularly-concentric lines showing in this specimen are due to the segregation of iron oxide from the body of the specimen.

11. (Labelled No. 32.) *Fine-grained decomposed sandstone.* Quarries, south side of the river, opposite Reefton. The oxidation of iron-pyrites is the active agent in the decomposition of these rocks.

12. (Labelled No. 33.) *Contorted green slate.* Locality: Quarries, south side of the river, opposite Reefton. This, which is in a less advanced stage of decomposition than the other specimens taken from this locality, shows that the change in the characters of the rocks here is due to the decomposition of very minute crystals of iron-pyrites, abundantly present in this specimen.

13. (Labelled No. 34.) *Bluish-green slate.* Locality: Quarries, south side of the river, opposite Reefton. This is an even-bedded rock, much the same in character as the slates which are being excavated in the low-level tunnel at Black's Point.

14. (Labelled No. 35.) *Contorted slate, decomposed.* Locality: Quarries, south side of the river, opposite Reefton. This has originally been a green rock; it is now a pale brown, fantastically covered by irregularly-concentric lines of deeper brown, due to the segregation of ferruginous material.

15. (Labelled No. 36.) *Decomposed slate.* Locality: Quarries,

south side of the river, opposite Reefton. This specimen, taken from a bed 3 or 4 feet thick, is a fair example of the condition of this and many thicker bands in the same vicinity. The bed, originally a green slate, has decomposed to a considerable depth. The whole mass is contorted into small foldings 4 inches or less across. The curves of these foldings would be that of a circle 8 or 10 inches or less in diameter. In splitting the rock these curved specimens can be lifted off one after the other, till a considerable number of the same size and curve are obtained directly superposed, when the original may split into two corrugations of smaller size, and these, blending, may after a time again take the original size and curve. One bed of this character in the western side of the quarry may be 15 to 20 feet thick.

16. (Labelled No. 37.) *Contorted slate.* Locality: Quarries, south side of the river, opposite Reefton. The specimen, decomposed and stained a rusty red, shows on its one side a single contortion, breaking up into a number of minute foldings which show on the opposite side: the progress towards these is to be seen in the end sections.

17. (Labelled No. 49.) *Micaceous sandstone.* Locality: The slip under the Vulcan Tramway, near the Wealth of Nations battery, Crushington. An example of the sandstones between Black's Point and Crushington.

18. (Labelled No. 50.) *Fine-grained sandy slate.* Locality: Slip near Wealth of Nations battery, Crushington. Taken as an example of the rocks between Black's Point and Crushington.

19. (Labelled No. 52.) *Sandstone.* Locality: The Keep-It-Dark Mine. From the deeper workings of this mine.

20. (Labelled No. 53.) *Green silky slate.* Locality: The Keep-It-Dark Mine. Taken as an example of this rock from the western side of the higher part of the syncline.

21. (Labelled No. 74.) *Sandstone.* Locality: First fluming from the head of the Keep-It-Dark water-race. A partly-decomposed pyritous sandstone.

22. (Labelled No. 75.) *Green pyritous slate.* Locality: First fluming from the head of the Keep-It-Dark water-race. This and the last specimen represent the rocks on the east side of the syncline between the mouth of Lankey's Gully and the boundary of the Devonian rocks.

23. (Labelled No. 78.) *Slate.* Locality: Garvie's Creek. This is the only rock-specimen in the collection which was obtained from the auriferous rocks east of the Devonian belt. The rocks on the east side, not differing in any particular from those on the west side, and not being so accessible, are for the present unrepresented except by this specimen.

24. (Labelled No. 92.) *Sandstone.* Locality: Boatman's Creek, near the Welcome battery. This rock differs in nothing from the ordinary sandstones in the Reefton section.

25. (Labelled No. 93.) *Blue slate.* Locality: Boatman's Creek, near the Welcome battery. An even-bedded slate found interbedded with heavy bands of sandstone in the spur between Capleston and the Welcome Mine.

26. (Labelled No. 97.) *Red slate.* Locality: Boatman's Creek, near the Welcome battery. Possibly the reddish colour of this specimen is due to decomposition; otherwise it is the only example of a red slate yet met with in the district in these beds.

27. (Labelled No. 98.) *Contorted green slate.* Locality: Track between Capleston and the Welcome battery. This rock has exactly the character of the green contorted slates on both sides of the syncline in the Reefton section.

28. (Labelled No. 107.) *Pyritous green slate.* Locality: Specimen Hill Mine, Little Boatman's Creek. Shows the character of this rock at some distance below the surface.

29. (Labelled No. 108.) *Pyritous quartzose sandstone.* Locality: Specimen Hill Mine, Little Boatman's Creek. Taken from the stuff excavated in the lower tunnel.

Rocks of an Intrusive Character.

Rocks of this description occur both near Reefton and at Boatman's Creek. They seemingly are found only among the upper beds of the series, and occur indifferently on either side of the syncline. As to their contemporaneity with the slates and sandstones with which they are associated, further evidence is wanted to establish this. In his report on the Westland District, speaking of these rocks, Mr. Cox says: "The North Star prospecting tunnel has been driven through slates for some distance; but a dyke, or what appears to be a dyke, of an intrusive crystalline rock of very considerable thickness has been cut, and the drive is barely yet through it." In the same report, describing the rocks of this series occurring in the southern part of Westland, he further says: "About two miles along the road from the [Okarita] forks towards the lake [Lake Mapourika] an outcrop is seen of bands of slate, much shattered, and interstratified with a syenitic rock which exhibits a striking resemblance to that seen in the North Star prospecting tunnel at Reefton. . . . . The stratification of these beds is unmistakable at this point, and were it not so marked I would certainly pronounce the syenitic rock as intrusive in character. Under the circumstances, however, it seems doubtful whether even that which occurs at Reefton is not interbedded with the other rocks of the district."

In the North Star tunnel the stratification of the slates and sandstones is not clear, and the supposed intrusive mass has certainly the appearance of such. Its occurrence again in the Phœnix Mine would support such a conclusion, as, if continuous (and it appears to be continuous between the points mentioned), it must intersect the bedding of the stratified adjoining rocks.

There are, however, associated beds of a tufaceous character, which are possibly stratified with the slates and sandstones.

30. (Labelled No. 46.) Locality: The United Inglewood and North Star Lease, west of Murray's Creek saddle.

31. (Labelled No. 47.) Locality: The Phœnix Mine, west of the upper part of Murray's Creek.

32. (Labelled No. 48.) Locality: The Phœnix Mine.

33. (Labelled No. 105.) Locality: Specimen Hill Mine, Little Boatman's Creek.

34. (Labelled No. 106.) Locality: Specimen Hill.

35. (Labelled No. 110.) Locality: Little Boatman's Creek.

36. (Labelled No. 117.) Locality: Near Welcome Mine, Boatman's Creek.

Quartz and Gold-bearing Specimens.

37. (Labelled No. 54.) *Pyritous quartz.* Locality: Keep-It-Dark Mine, Crushington.

38. (Labelled No. 80.) *Quartz.* Locality: Right bank of the Inangahua River, east of the Devonian belt. From a leader 6 to 8 inches wide.

39. (Labelled No. 95.) *Quartz.* Locality: The Imperial Reef, Boatman's Creek.

40. (Labelled No. 96.) *Quartz.* Locality: The Imperial Reef, Boatman's Creek.

41. (Labelled No. 102.) *Quartz.* Locality: Little Boatman's Creek. This specimen was taken from the large boulder of gold-bearing quartz and antimony lying in the creek-bed, and which is celebrated for the number of gold specimens which it has yielded. Spite of much that has been crushed or carried away from it, a mass of several tons yet remains.

42. (Labelled No. 103.) *Antimony ore showing gold.* Locality: Little Boatman's Creek. From the large boulder of quartz and antimony lying in the creek-bed.

43. (Labelled No. 113.) *Quartz and graphite.* Locality: Spur north of Specimen Hill Mine.

44. (Labelled No. 116.) *Quartz.* Locality: Range north of Specimen Hill Mine. Collected by Mr. Fitzmorris, and contributed for analysis. Contains gold.

45. (Labelled No. 122.) *Quartz.* Locality: Welcome Mine, Boatman's Creek. Spangled with crystals of antimony, and is visibly rich in gold.

46. (Labelled No. 123.) *Mixture of quartz and antimony.* Locality: Welcome Mine, Boatman's Creek. The specimen shows a good deal of gold, and attests the richness of the antimonious stone.

47. (Labelled No. 124.) *Quartz.* Locality: Caledonian Mine, Larry's Creek. Contributed by Mr. Gissen, Reefton.

48. (Labelled No. 131.) *Quartz.* Locality: Nil Desperandum

Mine, Crushington. Contributed by Mr. Gissen. Most of the gold-bearing specimens collected have no duplicates of them deposited at Reefton. The reason for this is that much richer and more showy specimens may be contributed by the mine managers and others interested in the welfare of the district.

Antimony Ore.

49. (Labelled No. 24.) *Antimony sulphide.* Locality: Souvenir Mine, Rainy Creek. Contributed by G. Wise, Reefton.

50. (Labelled No. 38.) *Antimony sulphide.* Locality: Murray's Creek Antimony Mine. Contributed by Mr. Bryne, Reefton.

51. (Labelled No. 45.) *Antimony sulphide.* Locality: Golden Treasure Mine, Murray's Creek.

52. (Labelled No. 51.) *Antimony sulphide with much quartz.* Locality: Vulcan Mine, Crushington.

53. (Labelled No. 56.) *Antimony sulphide.* Locality: Malcolm and Bayfield's Lease, Auld's Creek.

54. (Labelled No. 57.) *Antimony sulphide.* Locality: Fiery Cross Mine, Boatman's Creek. Contributed by Mr. Gissen, Reefton.

55. (Labelled No. 103.) *Antimony sulphide.* Locality: Little Boatman's Creek. From the big boulder lying in the bed of the stream.

56. (Labelled No. 118.) *Antimony sulphide.* Locality: Welcome Mine, Boatman's Creek.

Lead Ore.

57. (Labelled No. 130.) *Galena.* Locality: Caledonian Mine, Larry's Creek.

Iron.

58. (Labelled No. 129.) *Iron-pyrites.* Locality: Caledonian Mine, Larry's Creek.

Carbon Compounds.

59. (Labelled No. 55.) *Graphite.* Locality: Specimen Hill, Little Boatman's Creek. Contributed by Mr. Gissen, Reefton.

60. (Labelled No. 104.) *Graphite.* Locality: Lower Tunnel, Specimen Hill Mine.

61. (Labelled No. 112.) *Graphite.* Locality: Spur north of Specimen Hill Mine. Contributed by Mr. Fitzmorris; said to come from a very thick reef of like material.

62. (Labelled No. 113.) *Graphite.* Locality: Specimen Hill Mine, Upper Tunnel.

63. (Labelled No. 114.) *Graphite pug.* Locality: Specimen Hill Mine.

64. (Labelled No. 115.) *Graphite.* Locality: Specimen Hill Mine, upper old drive.

LOWER CRETACEOUS AND CRETACEO-TERTIARY SERIES.

These, although treated of separately, according to the divisions established in the general classification, must yet be regarded as members of a single sequence, for, although different groups of beds may possibly be unconformable to the strata above or below them, all are yet so closely related that they generally exist in the same areas; and the younger beds are never, by the omission of the intermediate, found resting on the upturned edges of the first-formed part of the sequence. Such omissions in the sequence as may be observed are not the result of denudation, but rather of a lapse of time during which no deposition took place within certain areas, and during which time some portions of the former area of deposit were upheaved but not again depressed, while at the same time the area of deposition was being extended in other directions. In some directions, therefore, overlap of the higher beds is observed, and in some places there is evidence that the first formed have contributed materials towards the formation of the higher beds, but in every case where the higher and lower beds are superimposed there is no stratigraphical unconformity between them.

In the district under review these beds come to the surface on either side of the Inangahua Valley, cropping out on the flanks of the ranges and dipping towards the middle part of the valley. On the western side of the valley (including the higher beds, the Cobden limestone, and the lower beds, the Hawk Crag breccias) the whole covers a considerable breadth of country, stretching back to the higher slopes of the Paparoa Range, and apparently makes connection with the coal fields of the coast-line farther south. Northward this western area stretches across the Buller Valley in the direction of the Mokihinui River into but partly-explored country. The extension of the coal formation in this direction was investigated in 1867 by Dr. Hector, and part of his description is given here in order to show the extent of the field. Describing the Karamea and Lyell Mountains coal field, he says: "Extending north from the Buller River, it is found in detached trough-like depressions among the mountains towards the source of the Wangapeka, Karamea, and Mokihinui Rivers. It then rises to the south-west, and forms the summits of the grassy, flat-topped ranges known as the Merino and Lyell Mountains. It is separated from the coal fields nearer the coast by mountains of granite and slate. The formation consists of four groups of strata, and was best seen in a vertical section of a mountain at the source of the Mokihinui River. The summit of this mountain is 4,700 feet above the sea, and the section shows the structure for 1,800 feet from the summit. The upper beds are indurated chalk-marls like those at Greymouth Gorge, but in them no fossils were detected. Under the marls is a group of grits and sandstones, which again rest on a thick series of

Septaria clays, in which I found Mesozoic fossils. The lowest member reached is a group of brown sandstones containing seams of coal."

Such is the extension northwards of the beds occupying the western side of the Inangahua Valley. The measures dip beneath the valley, and are without doubt continuous across it till they rise again on the western slopes of the auriferous range. In the lower grounds, however, the coal is presumably at such a depth from the surface as to preclude the feasibility of its being worked for many years to come, and therefore practically the outcrops on the east side of the valley must be looked upon as a distinct coal-bearing area.

Thus to the northward the eastern line of outcrop begins near the Buller River, and strikes south along the lower flanks of the ranges past Larry's Creek to Boatman's. Little is known of the breadth or connectedness of the outcrop till the coal-beds within the watershed of Boatman's Creek are reached. From Little Boatman's Creek to the north branch of the Inangahua the outcrop is continuously exposed, and thence as far as Reefton is only broken or superficially obscured by younger deposits. South from Reefton the coal rocks crop out between the auriferous rocks on the east and the Miocene gravels on the west side of the valley leading into Devil's Creek.

Another coal-bearing area of considerable extent lies further to the eastward, between the auriferous range and the western slopes of the Victoria Mountains. To the northward the exact locality of its commencement has not been ascertained, but this lies within the watershed of the upper part of Boatman's Creek. After crossing Boatman's Creek it is continued south to the Waituhi or north branch of the Inangahua River, beyond which the coal-bearing beds form the mountains between there and the upper part of Garvie's Creek. On this line further south a considerable outlier occurs in the upper part of Rainy Creek, and others yet further to the southward between there and Big River.

Two smaller areas of coal-bearing strata are developed near the sources of Murray's Creek and the two streams draining the right and left branches of Lankey's Gully.

The beds of this series consist of huge angular breccias, or breccias of finer material, conglomerates, quartzose grits, coarse- and fine-grained sandstones, micaceous and dark fine-grained shales or fireclays, associated with coal-seams. On these rest brown sandstones, succeeded by marly concretionary beds, usually of a dark colour. Above these lie gritty calcareous sandstones, followed by the more chalky beds representing the Cobden limestone.

The higher beds, which are found only on the west side of the Inangahua Valley, form a rugged mountainous country full of bold scarps and precipices, such as are common in a limestone

country; the underlying marly strata, where deeply cut into by streams, aiding in the production of this precipitous character.

The rocks more immediately associated with the coal-seams do not, as a rule, form such bold features, their materials being less coherent: yet in this respect much depends upon their position and the angle of dip which the beds have acquired. Where they are found at high elevations and in a nearly horizontal position vertical cliffs are formed, especially where sandstones predominate, or such cliffs once existent may be so wrecked and ruined that the whole margin of the coal-bearing area becomes a tumbled mass of huge fragments. This is well seen between the upper part of Murray's Creek and Lankey's Gully. At Boatman's, where the beds dip regularly at higher angles, and the harder are frequently interbedded with beds of a more friable description, a rugged serrated range is formed, with deep gulches between its peaks, and precipitous slopes everywhere. The lower beds present a different character; they are unstratified, and form no cliff due to the bedding of their materials. High vertical cliffs under certain conditions are formed by these rocks, of which Hawk Crag, on the Buller River, is an example; but, except where the country is very mountainous, they have a greater tendency to produce rounded outlines: at least this is their character in the eastern part of the district, as occurring in which they will have to be more particularly treated of. Under this heading, then, there are the subdivisions *a* to *h*, which will be taken separately and in order.

h. *Great Angular Breccias.*

On the east side of the Inangahua Valley these beds are first met with in proceeding from south to north, on the left bank of the Waituhi branch of the Inangahua River. They lie up the river beyond the Devonian belt, and the more eastern development of the auriferous rocks. They consist of an immense development of unstratified or but rudely stratified angular materials, derived from various formations, but with the rocks of the crystalline series predominating. On the left bank of the Waituhi a considerable bulk of their material has been derived from the rocks of the auriferous series; but the larger blocks, and perhaps the greater bulk of what constitutes the beds, are granitic. Masses of rock 5 or 6 feet in diameter, mixed with smaller, in a perfectly angular condition, form the lower part of the deposit. Followed to the eastward towards the granite mountains, and towards the higher portion of the deposit overlaid by the coal-beds, its materials, though quite as angular, gradually become less in size, and eventually pass into or are overlaid by waterworn pebbly beds, which may more properly be considered as belonging to the succeeding beds containing coal-seams.

In Garvie's Creek, draining the south side of the range between the Waituhi and the south branch of the Inangahua, these

beds have not been noted, the lowest beds there being waterworn conglomerates or subangular quartzose cements, corresponding to the auriferous cements of Lankey's Gully.

Between the north branch of the river and the upper part of Boatman's Creek, this breccia has a great development, both as regards the thickness of the deposit and the size of the materials forming it. It forms a range of hills, or rather mountains of moderate elevation, striking north across the creek, which, where it breaks through this range, exposes an immense conglomeration of huge granitic blocks, piled together without apparent order, and cemented together by equally angular materials of lesser size. Boatman's Creek was not sufficiently explored to mark the further eastern boundary of this deposit, but in that direction it probably is, as in the Waituhi, overlaid by coal-bearing strata. Of its extension further northward nothing is known. It is nowhere seen within the watershed of Larry's Creek.

Strictly speaking, these rocks can hardly be said to be present or known on the west side of the Inangahua Valley, since the southern portion of the watershed is unexplored, and towards the north they do not (in passing down the Buller Gorge) make their appearance till beyond the Blackwater River, passing which they form Hawk Crag, and are largely developed yet further west. They may be said to lie beyond the boundaries of the district of which this report treats, and can only be spoken of by way of comparison with the deposit on the eastern side of the Inangahua Valley. At Hawk Crag the breccias are compacted into a hard rock, and in this respect resemble more the breccia-beds of the Te Anau series than rocks of the Cretaceous period. In the lower parts of the deposit the materials are wholly a dark-coloured submetamorphic rock, not unlike the auriferous rocks at Larry's Creek. The angular pieces of which the whole is composed are small compared with what is seen in the south bank of the Waituhi, or at Boatman's Creek, and there is a marked scarcity of granite boulders. Followed upwards into the higher part of the deposit, granite blocks become more abundant, and the materials of the breccia are much coarser.

Whence they are derived, and what is the mode of their production, it may not be fit to discuss at great length here. Apparently their source has been not greatly distant from where they are now found, and seemingly they have travelled mainly from the north or north-east in the opposite direction. Viewed in this light, we find slaty material predominating in the breccias where such rocks lie to the north and north-east of the localities so distinguished, and granitic material in like position where granites are developed to the north and east. Such-like materials, did they belong to more modern and superficial deposits, would most certainly be referred to the action of ice in the form of glaciers; but, in so limiting the causes capable of producing these,

the question would naturally arise, Did ice also make and bring together or disperse over a large area the great breccias at the base of the Upper Devonian beds, the Te Anau series, or were other causes competent to produce both?

g. Quartz Grits and Auriferous Cements.

These, succeeding to the great angular breccias, are over wide areas developed as the basement beds of the series, and—though, when found together in the same section, they are the upper beds—may elsewhere be in some sort considered as the equivalents of the breccias. They are everywhere the lowest beds of the coal-bearing rocks as these are developed along the west side of the auriferous range; they are thin or have a considerable thickness according as local circumstances appear to have retarded or favoured their deposition. In Garvie's Creek they appear to be of considerable thickness, and towards its source to rest on the breccias just described. On the banks of the Waituhi the pebble-beds interbedded between the breccias and the coal sandstone must be considered as belonging to this section. In Boatman's Creek, at Capleston, they have a considerable development as gravelly conglomerates interlaminated with false-bedded patches of finer materials, and succeeded or closed by coarse gritty sandstones. At Lankey's Gully and in the upper part of Murray's Creek the beds are seldom more than 6 feet thick, and are there immediately overlaid by sandstones, succeeded by coal shales. Naturally they are nothing more than the base of the coal-bearing beds, and would not require a separate description but for the fact of their being at certain places of an auriferous character. Gold has been found in these beds at Boatman's Creek, Murray's Creek, Coal Creek, Lankey's Gully, and Garvie's Creek, and I do not doubt that, more or less, they are everywhere auriferous. Except in Coal Creek and at Lankey's Gully they have neither been worked nor much prospected for gold. In the localities last named they have been worked intermittently for several years past, and latterly the Lankey's Gully Cement Company have secured a considerable area of ground, and seem determined to work the deposit there on a large scale.

Between the head of Lankey's Gully and Coal Creek the height of land is formed of nearly horizontal strata, chiefly sandstones, but associated with micaceous shales and coal-seams, of which the one worked is of considerable thickness. At the base of this sequence lies a bed of sandstone, and underneath that the auriferous cement. This is exposed at the foot of a line of cliffs extending from near the coal mine east across the principal feeder of this branch of the creek to the west side of the spur between the two main branches of Lankey's Creek.

Before reaching the crest of the spur the line of cliffs terminates, and a tumbled mass of sandstone blocks, with cement adhering, succeed, generally speaking so far in place that the cement-

bed retains its natural position. In this part is situated most of the ground worked for gold, the cements being crushed or partly decomposed, and the gold thus set free. Elsewhere also some work has been done where the cements are exposed truly *in sitû*, and covered by the sandstones and coal shales undisturbed. In such undisturbed portion of the deposit a considerable excavation has been made at the old battery site, situate 50 or 60 yards north-west of where the line of cliff ends. The cement is here a foot or more, but never more than 2 feet thick, and very hard, requiring the use of powder for its extraction. Thin though it be, most of the gold lies in the first six inches of the cement, and even then it is difficult to find specimens showing gold. Nevertheless it must have yielded results to have induced the excavation of a cavernous space extending some 40 or 50 feet along the outcrop, and, in some places, backward for 25 feet.

Further north, where the line of cliff crosses the small creek already mentioned, a second excavation has been made for the extraction of the cement *in sitû*. Less work has been done here, and, as far as I can learn, with not very satisfactory results.

Hitherto the best paying ground has been found east of the line of cliffs, where large blocks of cement-bearing rock strew the surface of the spur. At one place called "The Island" something like 150 oz. of gold is said to have been obtained from an area about one chain in extent; but, as to this, no sure information can be obtained, and the accounts differ. All, however, agree that the ground was payable.

The question for the future will, however, be this: Can the cements be worked with profit after all the partly-decomposed margin has been cleared away, and nothing remains except the cement-bed *in sitû?* If so, an area fully half a mile square is available to work upon, extending north-east to the source of the main branch of Lankey's Creek and north into Coal Creek.

Much of this ground is already taken up as leases for the purpose of working the cements supposed to be present in them. A specimen taken from the eastern outcrop of the cement in the head of the left branch of Lankey's Creek yielded a small quantity of tin-sand, but no gold. In the lower part of Coal Creek gold and tin-sand occur in a bed of cement at the base of the coal-bearing beds; it rests, like the cements at Lankey's Gully, on the upturned edges of the Devonian rocks without the interposition of other strata.

At Cement Town, where first discovered, there might be some doubt as to whether the cement there truly passed beneath and underlaid the coal strata, as, where first found in the back of a cliff of coal sandstone resting on Devonian cherts, it rapidly thinned out, and was not to be seen on the other side of the creek, where the lowest beds of the coal rocks are seen resting on the Devonian beds.

In like manner, at the lower end of the gorge of Coal Creek, the auriferous and tin-bearing cement there cannot clearly be seen passing under the adjoining coal strata; but I cannot doubt that it occupies such a position. However this may be, the position of the cements in the upper part of Lankey's Gully is perfectly clear, and is much as shown in the following section:—

Section E.–W. across the Cement Company's Lease, Lankey's Gully. *a*. Lower cherts, Devonian. *b*. Upper part of the Devonian rocks. *c*. Cement-bed, resting on Devonian strata. *d*. Coal sandstone and micaceous shales. *e*. Recent slope deposit. A. Lankey's Gully.

The cements have been excavated at *d*, and proved auriferous, and also, to a small extent, yield tin-sand. It cannot be doubted but that many creeks owe their gold deposits to or have had them enriched by the vicinity of these gold-bearing cements. Almost every creek which rises in or cuts through them has been worked for gold. At many places, however, the matter is complicated by the presence of other deposits also yielding gold, and contributing towards the enrichment of the alluvial wash in the creek-beds.

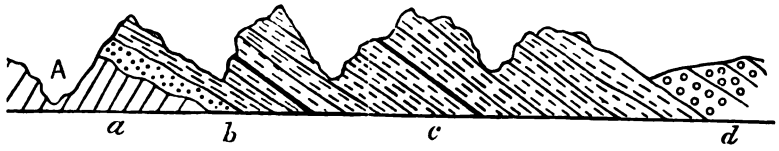
f. *Grits, Sandstones, and Shales, with Coal.*

On the western side of the Inangahua Valley comparatively little is known about these beds, and except at Coal Creek, on the Buller River, I have not examined them. Prospectors report the presence of coal-seams on the west side of the valley as far south as abreast of Reefton, and it cannot be doubted that a continuous outcrop of these rocks occurs behind the first hill-slopes on the west side of the valley. On the opposite side of the valley, tracing them south from the Buller River, coal grits and sandstones are met with on the east side of the range on the road crossing from the Inangahua Valley to the Lyell Township. The overlying strata of the same sequence show in different streams between there and Larry's Creek, but the coal-beds themselves have been little explored till reaching Boatman's Creek. In Little Boatman's Creek a coal-seam is being opened out and worked in the hills west of the auriferous rocks, the creek valley here running along the junction of the two formations. The position of this seam is seen in the section at page 129, showing the rocks from Specimen Hill west. The seam is a thick one, but near the outcrop is crushed, and much of it in a culmy condi-

tion. Only the harder portions (which occur as isolated masses) are used, principally for blacksmiths' work, being better adapted for this than the harder coal found at Capleston.

On the south side of Boatman's Creek, at Capleston, the coal-bearing beds are finely exposed. The lowest beds resting on the auriferous series are the cements already treated of under section *g*. These, consisting mainly of well-rounded pebbles of quartz and metamorphic rocks, along the outcrop on either side of the creek lose their coherence, and assume at many places the appearances of a recent gravel-bed. The cements are overlaid by coarse grits of considerable thickness, followed by alternations of gritty sandstones and shales, with indications of coal, and eventually by a coal-seam some 4 feet thick, parted by a band of indurated coaly shale into two distinct beds.

Coarse grits again follow, and higher in the section further bands of shale; and a second, if not a third, coal-seam is indicated. This upper seam was at one time exposed in some gold-workings which have now been filled in, and the coal does not show at the surface. Traces of it are, however, met with in the material excavated, and which has since been used in forming the road which passes over the place where the seam was laid bare. The seam is reported to have been 5 feet thick. Succeeding this higher seam, grits and coarse sandstones continue some distance down the creek, till eventually overlaid by the gravels belonging to the Miocene period. The strike of the coal-beds opposite Capleston is N.–S., and the dip W. at from 27° to 30°. Below is a sketch of the section seen on the south side of the creek :—



Section of coal strata on the south side of Boatman's Creek, at Capleston. *a*. Rocks of the auriferous series. *b*. Cement conglomerates, auriferous. *c*. Coal strata with coal-seams. *d*. Gravels belonging to the Miocene period. A. Boatman's Creek.

The next section showing coal is exposed on the right bank of the Waituhi, where, with the associated beds, the seam is seen standing at a high angle, and dipping down the river or to the westward. On the south side of this river, in Painkiller Creek, there is an abundance of large blocks of grit and sandstone, resting on slates, but neither regular strata nor coal-seams have yet been discovered.

Nearer Reefton, and within the watershed of Burke's Creek and its tributaries, the coal rocks lie at a much lower angle, and dip to the N.W., forming a broad terrace table-land, the surface of which shows to some depth a deposit of coarse boulders and finer materials

overlying the coal strata: this is only seen in the sides of th gullies cutting into the table-land, and at places in the beds of the small streams draining it and the adjacent ranges which are formed of auriferous slates and sandstones. In this area, convenient to the Town of Reefton, there is a fine seam of pitch-coal, from which the main supply of fuel required is supplied. The rocks associated with this are gritty sandstones, and micaceous and fine-grained dark-coloured fireclays.

In Liverpool Davis's Gully, south of the Inangahua and opposite Reefton, a small area of coal strata crops out on the left bank of the creek. This is tilted to a high angle, and dips to the west. The strata consist of carbonaceous fireclays as the lowest beds, followed by a highly ferruginous clay, which in some places becomes a hæmatite containing 50 per cent. of iron oxide. The entire extent of the outlier is very trifling, and it appears to be but a small portion of the coal strata entangled amongst the auriferous rocks by the movements which have tilted the same series to considerable angles further south.

In the valley of Soldiers' and Devil's Creeks a narrow exposure of coal strata lies between the ranges formed by the auriferous series on the east side and the hills formed of Miocene gravels on the west side. At this place the coal rocks dip at rather high angles to the west and south-west. One or more coal-seams are here present, and that recently opened by Mr. Breen is 4 feet thick, possessing somewhat the character of a bituminous coal.

At Rainy Creek the coal-beds, as horizontal strata, cover the junction between the auriferous series and the Devonian formation. The beds associated with the coal, a 10-foot seam, are gritty and brown sandstones and black slaty shales, the latter abounding with impressions of dicotyledonous leaves. The western side of this area of coal rocks is deeply involved, as a sharp narrow syncline, between the Devonian beds on the one side and the auriferous rocks on the other (*see* section at page 110).

On the opposite side of the Inangahua River the coal strata, where first met with in following up Garvie's Creek, are highly inclined along the eastern margin of the coal-bearing area, but are nearly horizontal in the range forming the watershed between the upper part of the creek and the Waituhi. On the east side of the creek also the coal-beds, with auriferous cements at their base, form horizontal strata capping the spurs in that direction. In the highly inclined strata one and a half miles up the creek one seam 6 or 7 feet thick is met with, and other smaller seams of coal occur in the same beds. In the horizontal strata at the source of the creek one thick seam is known to occur, and others are supposed to be associated with it. In the black shales of these beds iron ore of good quality is found. This, which could not be traced to its source, occurs as boulders and concretionary masses

in the *débris* of the creek-bed. The iron ores are full of plant-impressions, such as are found in the black shales, in which it appears the concretions or elliptic masses of this ore occur. At the base of the series auriferous cements are found on the spurs east of the lower part of the creek, and towards the north-west source these probably rest on the great angular breccias.

The following sketch shows the position of the coal-beds in Garvie's Creek, and also the auriferous slates and sandstones on either side between the granite mountains and the Devonian belt:—

Section from the Devonian belt east across Garvie's Creek to the granite. *a*. Granite and metamorphic rocks. *b*. Devonian cherts. *c*. Sandstones and slates of the auriferous series. *d*. Grits, sandstones, and shales with coal-seams. *d'*. Highly-inclined coal strata in Garvie's Creek.

Sandstones and shales with coal-seams show in the north bank of the Waituhi, or north branch of the Inangahua. These dip to the east, and abut against the granite belt in that direction. They strike north into the upper part of Boatman's Creek, where, east of the auriferous rocks and in the gorge cut through the great breccias, coal-shales and pieces of coal are occasionally met with in the bed of the stream. As far as I am aware, no seams have yet been discovered in this upper part of the creek.

The outliers of coal rocks occurring between the northern source of Murray's Creek and Lankey's Gully are of some consequence, as no less than four mines are worked in these outliers. The area of that at the head of Murray's Creek is but small. The seam of coal worked by the Golden Fleece Company for supply of their battery-engine is opened out at the western edge of the outlier. It is of great thickness—some 30 to 40 feet—and forms an excellent steam coal. Specimens taken from the south drive are of a bituminous character, yielding a hard coherent coke (*see* analysis accompanying catalogue of the specimens from this series). The Westland Coal Mine, in this outlier, is situate on the east side of Murray's Creek, a little above the Westland battery. The rocks here are much the same as elsewhere associated with the coal. Near the mouth of Coal Creek sandstones are overlaid by micaceous shales forming a little hill, in which is situated the Energetic Coal Mine. At the south-west corner of this outlier is situated the Lankey's Gully Coal Mine.

e. *Brown Fossiliferous Sandstone.*

This rock is found at Rainy Creek overlying the coal-beds, and, with the beds *d*, appears to be intermediate between the coal shales with terrestrial plant-remains and the dark marly strata

underlying the limestones which form the higher part of the sequence. Several of the forms at Rainy Creek are identical with fossils found at Ten-Mile Creek, north of Greymouth.

d. *Impure Fossiliferous Limestone.*

These beds occur somewhere within the watershed of the north branch of the Inangahua, where stray fossils, a large *Ostrea* and a *Cucullæa*, are found in the beds of some of the creeks; but these have not been met with *in sitû* as yet.

A fossiliferous bed occurs at the junction of the Inangahua with the Buller which is referred to this horizon. This is highly foraminiferous, and, besides, contains the large *Ostrea* mentioned, and a number of other fossils rather badly preserved. These rocks at the Inangahua are overlaid by sandstones dipping up the river, which are in turn overlaid by the marly beds underlying the equivalents of the Cobden limestone at that place.

c. *Dark Marly Beds, with Concretions.*

These are best seen between the landing ferry and the junction of the Inangahua. Below the landing they form cliffs on the banks of the river, and are exposed as fossiliferous strata near Christie's, also in some of the larger creeks which fall into the river on the east side. The same beds are exposed under the limestone for some distance along the Buller Road below the junction of the Inangahua, where they contain moderate-sized concretions. Generally speaking these beds are not rich in fossils, but near Christie's there are beds in which such are moderately plentiful.

b. *Gritty Foraminiferous Coral-rag.*

This forms the base of the Cobden limestone, and is well seen in the banks of the Inangahua, where, above the landing, the river has cut a narrow gorge through these rocks. Besides fossils of larger size, this rock is largely composed of *Foraminifera* and a small branching coral, which is very abundant in the limestones near Brighton, on the coast-line south of Charleston. The beds on the Inangahua dip at low angles to the north-east, and pass under the representative of the Cobden limestone at the ferry.

a. *Cobden Limestone.*

This closes the sequence of Old Tertiary and Cretaceous formations, and is developed along the west side of the Inangahua Valley, mainly in the north-west corner, forming rather mountainous country between the lower part of the Inangahua and Coal Creek, which falls into the Buller River. These limestones are more a calcareous sandstone than the typical rocks at Greymouth, but contain the same fossils, or rather such fossils as are found in them are for the most part found also at Greymouth.

LIST OF ROCKS AND MINERAL SPECIMENS COLLECTED FROM THE CRETACEOUS AND CRETACEO-TERTIARY SERIES.

1. (Labelled No. 26.) *Gold-bearing cement.* Locality: The Cement Company's Claim, Lankey's Gully.

2. (Labelled No. 30.) *Quartz boulder, with iron-pyrites and gold adhering.* Locality: The Cement Company's Lease, Lankey's Gully.

3. (Labelled No. 59.) *Coal shale.* Locality: Garvie's Creek. This is a dark slaty shale, much indurated, which is commonly the case where the coal-beds are much disturbed, as they are in the locality of the specimen.

4. (Labelled No. 60.) *Calcareous concretion.* Locality: Garvie's Creek.

5. (Labelled No. 82.) *Quartzose sandstone.* Locality: The Cement Company's Lease, Lankey's Gully. This stone is used locally for the manufacture of grindstones, and for such purpose proves to be of very good quality.

6. (Labelled No. 83.) *Coal sandstone.* Locality: Lankey's Gully. Taken from the thick bed of sandstone overlying the auriferous cements.

7. (Labelled No. 84.) *Auriferous cement.* Locality: Johnson's Claim, Lankey's Gully.

8. (Labelled No. 85.) *Pyritous cement.* Locality: The Cement Company's Lease, Lankey's Gully.

9. (Labelled No. 86.) *Rusty cement.* Locality: Lankey's Gully.

10. (Labelled No. 89.) *Soft sandstone, with plant-remains.* Locality: Newcastle Coal Mine (Breen's), road to Devil's Creek. These specimens proved so incoherent that they are not now represented in the collection.

11. (Labelled No. 94.) *White gritty quartzose sandstone.* Locality: Near Capleston, from the coal mine on the south side of Boatman's Creek.

12. (Labelled No. 99.) *Quartz grit.* Locality: Near Capleston, from beds overlying the coal-seam worked on the south side of Boatman's Creek.

13. (Labelled No. 100.) *Quartz grit.* Locality: Near Capleston, from beds underlying the coal-seam on the south side of Boatman's Creek. This rock passes downwards into alternations of grit and conglomerate overlying the coarser beds at the base of the series.

14. (Labelled No. 126.) *Micaceous shale.* Locality: New Durham Coal Mine, near Reefton.

15. (Labelled No. 127.) *Black shale or fireclay.* Locality: New Durham Coal Mine, Reefton.

Specimens containing Gold and Tin.

16. (Labelled No. 42.) *Coarse angular cement.* Locality: Coal Creek, from the Cement Claim at the lower end of the gorge. Gold and tin ore are both observable in this specimen.

17. (Labelled No. 43.) *Angular cement, showing gold.* Locality: Coal Creek, from the Cement Claim at the lower end of the gorge.

18. (Labelled No. 87.) *Quartz boulder, with gold and grains of tin ore adhering.* Locality: Cement Company's Lease, Lankey's Gully.

19. (Labelled No. 121.) *Auriferous cement.* Locality: Lankey's Gully. This was a sample of light-brown cement, from the Cement Company's Lease, which, on being tested, proved rich in gold, and contained also a small percentage of tin-sand.

Iron Ores.

21. (Labelled No. 39.) *Ferruginous clay.* Locality: Liverpool Davis's Gully, Reefton. Some samples of this contain 50 per cent. of iron oxide.

22. (Labelled No. 41.) *Ironstone.* Locality: Garvie's Creek.

23. (Labelled No. 79.) *Ironstone.* Locality: Garvie's Creek. Much the same in quality as No. 22.

Coals.

24. (Labelled No. 28.) *Pitch coal.* Locality: New Durham Mine, near Reefton.

25. (Labelled No. 58.) *Pitch coal.* Locality: Garvie's Creek.

26. (Labelled No. 88.) *Pitch coal.* Locality: Newcastle Mine (Breen's), road to Devil's Creek.

27. (Labelled No. 91.) Locality: Capleston. From the seam worked on the south side of Boatman's Creek.

28. (Labelled No. 109.) Locality: Little Boatman's Creek.

29. (Labelled No. 120.) Locality: Golden Fleece (Ajax) Coal Lease, head of Murray's Creek.

30. (Labelled No. 125.) Locality: Old workings, New Durham Mine, Reefton.

Fossils.

A number of plant-remains were collected from the coal-beds exposed in the gullies cutting into the table-land at the back of Reefton; and leaves also show freely in the ironstones obtained from Garvie's Creek.

UPPER MIOCENE GRAVELS.

These are chiefly seen on the eastern side and closing the southern end of the Inangahua Plain. Between Larry's Creek and Reefton they form the higher terraces and first hills skirting the plain on that side. South of Reefton they form the hilly country between there and Squaretown, and from the latter place stretch south along the east side of the Little Grey. The beds are mainly composed of waterworn gravels, derived from various rocks. Their materials are largely granitic and schistose between Reefton and Squaretown, and are more of a sandstone character farther to the north. Though in the main composed of coarse gravels, beds of finer material are of frequent occurrence in the

hills north-east of Squaretown; and seams of lignite are at some places exposed on the banks of the Inangahua River, where that river, crossing the southern end of the plain, sets hard against these rocks.

The beds are at many places auriferous, and sluicing claims have been opened in them in several places. Two such workings, now abandoned, are to be seen on the road to Devil's Creek, and one or two are still working within the watershed of Boatman's Creek; but the gold seems generally too sparsely distributed through the mass of gravels, and not till it has been concentrated by the action of the creeks cutting deeply into these beds is it found generally payable.

Pliocene Gravels and Drift.

Deposits belonging to a period younger than the Miocene gravels, and yet much older than the recent deposits which fill the river valleys, have at one time been spread over the high levels of the southern part of the district. These are now in great part removed by denudation, but over all the higher land from the head of Murray's Creek to Merry-Jig occasional granite boulders of large size and patches of coarse granitic gravels show where there has once been a continuous deposit. A deposit referable to this age lies round the source of Soldiers' Creek, and caps the hills between there and the fall to the Inangahua, opposite Reefton. The coarse drifts worked for gold at Merry-Jig are also probably of this age.

Recent.

These beds cover the low grounds and fill the river-beds of the district. They need only be specially mentioned as forming marginal terraces rising on the sides of the narrow parts of the river-valleys. Deposits of this kind are seen along the south branch of the Inangahua, between the mouth of Rainy Creek and Crushington, where fine granitic drifts, indistinctly stratified, rest against the slopes of the ranges on the north side of the river. These beds differ in appearance from ordinary river-gravels, and, showing at places a horizontal stratification, indicate deposition in a lake or still water. Near the eastern boundary of the Devonian rocks the lower part of these deposits is composed of angular materials of the neighbouring rocks, overlaid by a coarse granity wash, and at higher levels by the gritty sands mentioned. The finer-grained materials rise to 150 feet on the sides of the hills, and at various places have been driven through during the construction of the Wealth of Nations water-race. A similar deposit of granity grit, clearly bedded, has been cut through in the saddle on the road from Reefton to Devil's Creek.

By Authority: George Didsbury, Government Printer, Wellington.—1883.

TW

Colonial Museum and Geological Survey of New Zealand.

JAMES HECTOR, M.D., C.M.G., F.R.S.,
DIRECTOR.

REPORTS

ON

GEOLOGICAL EXPLORATIONS

DURING 1884.

WITH MAPS AND SECTIONS.

PUBLISHED BY COMMAND.

NEW ZEALAND:
BY AUTHORITY: GEORGE DIDSBURY, GOVERNMENT PRINTER, WELLINGTON.

1885.

Stanford University Libraries
3 6105 011 082 455